Atrazine Technical Briefing

April 16, 2002

Overview

Lois Rossi, Director
Special Review and
Reregistration Division

Goals of the Briefing

- Provide legal context & regulatory history
- Discuss OW jurisdiction over atrazine
- Provide usage profiles
- Present risk assessments, identify risks of concern
- Begin risk management dialogue
- Discuss next steps
- Take questions and comments

Introduction & Background Information

Kimberly Nesci Lowe
Atrazine Chemical Review Manager
Special Review and
Reregistration Division

Briefing Schedule

- Introduction
- Use Profile
- Dietary Risk Assessment
  - Food
  - Drinking Water
- Residential Risk Assessment
- Aggregate Risk Assessment
- Occupational Risk Assessment
- Ecological Fate and Effects Risk Assessment
- Office of Water's Jurisdiction over Atrazine
- Risk Management Dialogue

Atrazine – Regulatory History

- Herbicide
- ~76 million pounds used annually
- First registered in 1958
- Special review chemical
  - Triazines special review began in 1994 for carcinogenicity concerns
  - Atrazine special review will be closed out after the IRED is completed
- One of the 5 ai's in EPA's proposed pesticide management plan (PMP) rule

Atrazine – Regulatory History

- Atrazine also regulated by the Office of Water under:
  - The Safe Drinking Water Act (SDWA); and
  - The Clean Water Act (CWA)
- OW will be included in risk management decisions

Atrazine – Regulatory History

- Cancer classification
  - Late 80s, classified as a "possible human carcinogen"
  - In June 2000, FIFRA SAP recommended reclassification as "not a likely human carcinogen"
  - Agency agreed with SAP, CARC classified atrazine as "not a likely human carcinogen"

Atrazine – Regulatory History

- Prior Mitigation – 1990 (groundwater concerns)
  - Reduction of maximum seasonal application rate for corn and sorghum to 3 lb ai/A (from 4)
  - Reduction of maximum rate on non-cropland and total vegetation to 10 lb ai/A (from 40)
  - Required post emergent applications to corn be made before corn reaches 12 inches in height

Atrazine – Regulatory History

- Prior Mitigation – 1990 (cont.)
  - Deleted rangeland, proso millet, and pineapple uses
  - Restricted Use classification (except lawn care, turf, and conifer uses)
  - Institution of a well-head protection plan (50 foot setbacks)
  - Prohibition of chemigation
  - Institution of construction requirements for bulk storage facilities

Atrazine – Regulatory History

- Prior Mitigation – 1992 (surface water concerns)
  - Further reduction of the total seasonal application rates for corn and sorghum to 2.5 lb ai/A per year (1.5 pre-; 1 post-emergent)
  - Deleted use for total vegetation control in non-cropland
  - Expansion of setback requirements
    - 50 foot setback around surface water sources for mixing and loading
    - 66 foot application setback from points of entry where field surface water runoff enters surface water sources
    - 200 foot application setback around lakes and reservoirs

Atrazine – Regulatory History

- Prior Mitigation – 1996 (surface water concerns)
  - Reduced environmental exposure by label restrictions for tile-terrace fields containing standpipes, as follows:
    - Do not apply within 66 feet of standpipes in tile-outletted terraced fields;
    - Apply to the entire tile-outletted terraced field and immediately incorporate to a depth of 2-3 inches; **or**
    - Apply to tile-outletted field under no-till practice only when practicing high crop residue mgmt.

Atrazine 6-Phase TRAC Process

Phase	Description	Dates
1	Registrant "Error Only" Review	12/1/2000 (HH) 12/8/2000 (Eco)
2	EPA Considers Registrants' Comments	12/00 - 2/01 (HH) 12/00 - 9/01 (Eco)
3	60-Day Public Comment on the Preliminary Risk Assessments	2/14/2001 (HH) 9/26/2001 (Eco)
4	EPA Revises Risk Assessments	Completed 4/2002
5	60-Day Public Comment on Risk Management Ideas	4/2002
6	EPA Develops Risk Mgmt. Strategies	6 & 7/2002

Phase 3 - 60-Day Public Comment Period

- Began February 14, 2001 (Human Health) and September 26, 2001 (Eco)
- Over 250 comments received
- Private citizens, growers and grower groups, water associations, academia, public interest groups, and registrants

Phase 3 – Substantive Comments Received

- Application of the 10x FQPA Safety Factor
- Selection and application of toxicological endpoints
- Cancer classification (not likely to be carcinogenic to humans)
- Use and usage information
- Requests that EPA conduct a probabilistic ecological assessment

Phase 3 – Substantive Comments Received

- Submission of a probabilistic dietary and a probabilistic ecological assessment
- Risks to salmon and its habitat
- Endocrine disruption in reptiles and amphibians
- Potential endocrine disruption in humans
- OW/OPP coordination

Phase 4 – Revisions to the Risk Assessments

- Revisions to the Human Health Risk Assessment
  - Inclusion of a probabilistic drinking water assessment
  - Review and incorporation of additional data submitted (e.g., hand press study)
- Revisions to the Environmental Fate and Effects Risk Assessment
  - Discussion of the probabilistic eco assessment submitted by the registrant

Atrazine IRED Schedule

- April - June – Phase 5 60-Day Public Comment Period
- April - July – Risk management discussions
- August 2002 – IRED completed

Atrazine Use Profile

Steve Smearman, Economist
Biological and Economic Analysis Division

Use Profile

- Triazine Herbicide
  - Applied both Pre and Post Emergence
  - Controls both broadleaf and grass weeds
- Most are classified as Restricted Use due to ground and surface water contamination issues
  - Exception for use on turf (golf course, sod farms, and residential lawns) and conifers
- 6 Formulations of End Use Products
  - Over 150 Active Labels
  - Package mixed with over 15 other herbicides

Use Profile

- End Use Products
  - Emulsifiable concentrate, flowable concentrate, granular, soluble concentrate/liquid, wettable powder, water dispersible granules (dry flowable)
- Application Methods
  - Broadcast; Band treatment; Directed spray; Low volume spray (concentrate); Soil incorporated treatment
- Application Equipment (list is only representative)
  - Boom sprayer, Band Sprayer, Fixed-wing aircraft; Helicopter; Granule applicator; Hand-held sprayers; Hose-end sprayer; Knapsack sprayer; Pneumatic (compressed air) applicator

Use Profile

- Agricultural Uses
  - Food Crops
    - Field corn, sweet corn (fresh and processed), sugarcane, sorghum, winter wheat, guava, macadamia nuts
  - Non Food Crops
    - Hay, pasture, summer fallow
  - Silviculture
    - Forestry or woodlands, conifers, woody ornamentals, Christmas trees

Use Profile

- Residential/Industrial/Recreational Uses
  - Residential Turf (Lawn care operators and homeowner applied), parks, institutional turf
  - Golf courses, sod, landscape maintenance
  - Roadways, industrial facilities

Use Profile

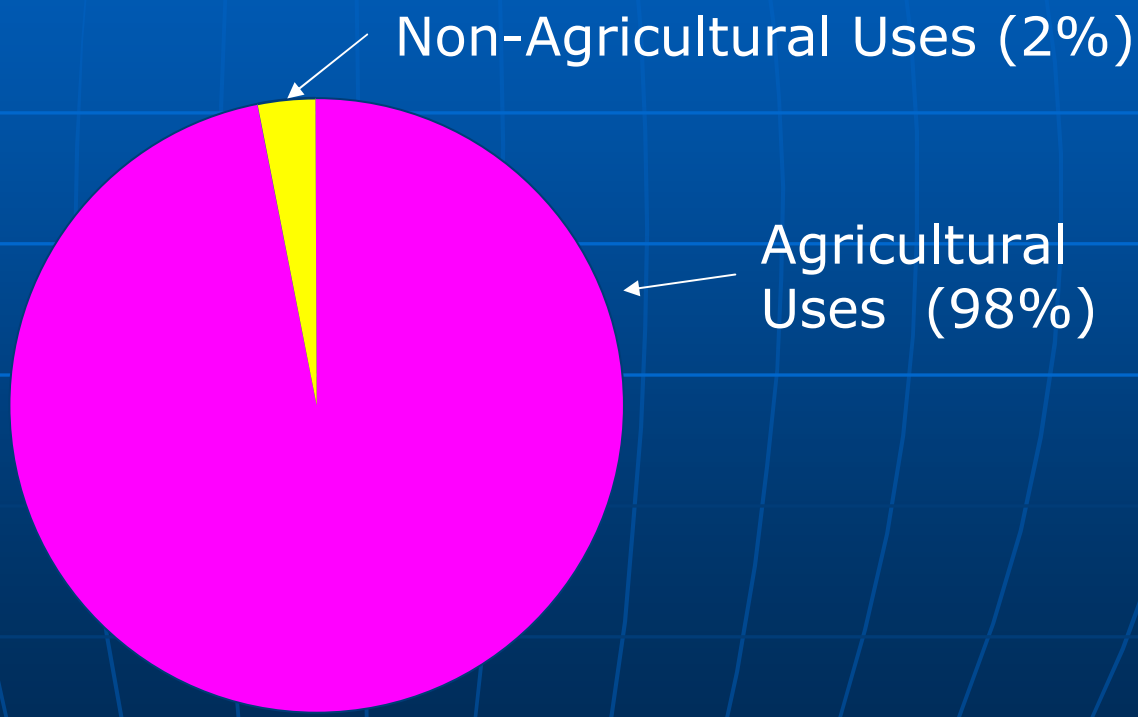
- **Average Application Rates**
  - Agricultural Uses
    - Predominant use is field corn with an average rate of 1 pound ai per acre per application
    - Some uses with rates up to 4.0 lbs ai per acre per application
    - Annual maximum use for field corn is 2.5 lbs ai per acre and for sugarcane is 10.0 lbs ai per acre
  - Non-Ag. Uses
    - Turf usually at 2.0 lbs ai per acre or less

Use Profile

- **Typical Usage**
  - Estimated annual average is 76.4 million lbs ai applied for all sites
  - Agricultural food sites – 74.8 million lbs ai applied
    - Largest agricultural market is field corn at 85% of total lbs applied to agricultural use sites followed by:
      - Sorghum (10%)
      - Sugarcane (3%)
  - Non-food agriculture and Non-Agricultural sites – 1.6 million lbs ai applied
    - Largest non-food market is turf applications by lawn care operators in the Southeast US

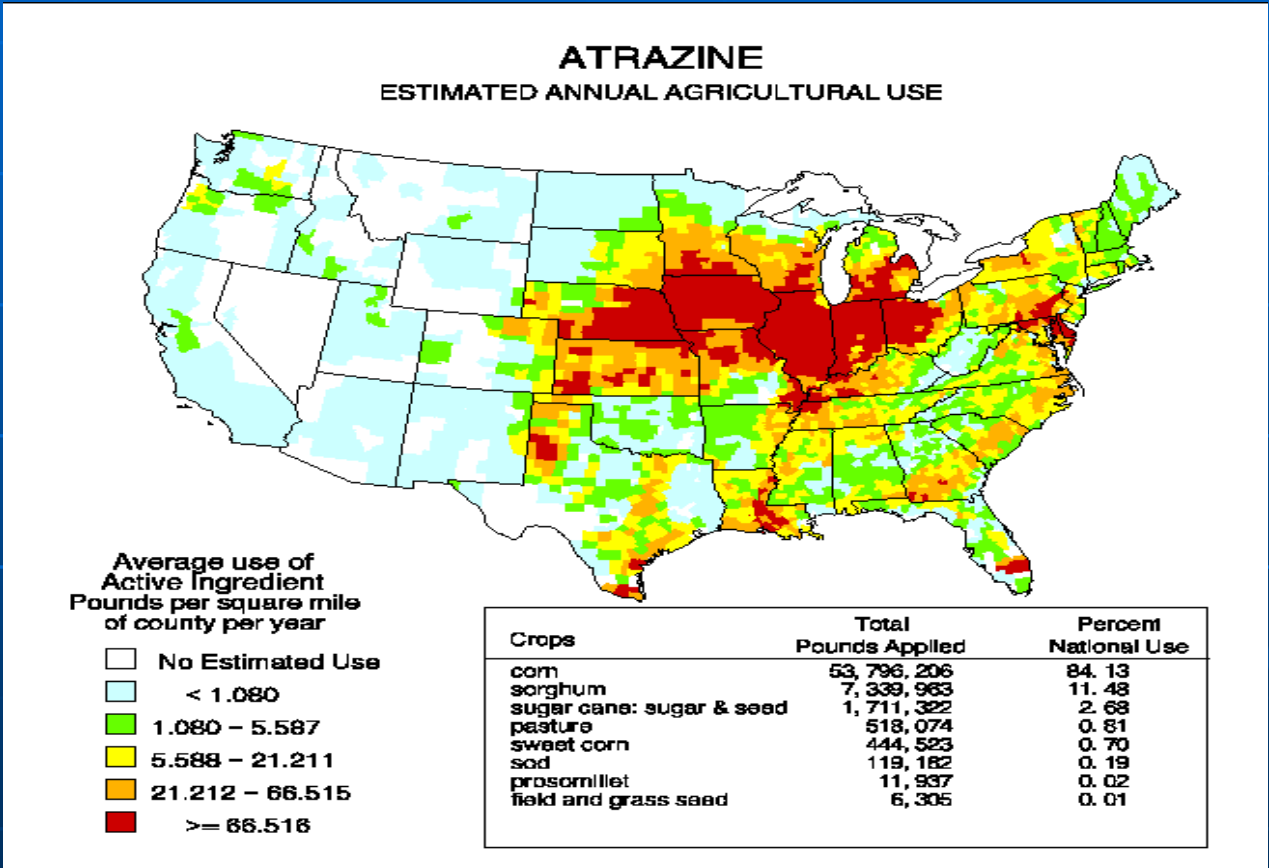
Use Profile

Atrazine Usage
As a % of Total Pounds Applied
For Agricultural and Non-Agricultural Markets



Estimated 76.4 million lbs applied
Source: EPA Data, 1990 - 2000

Use Profile

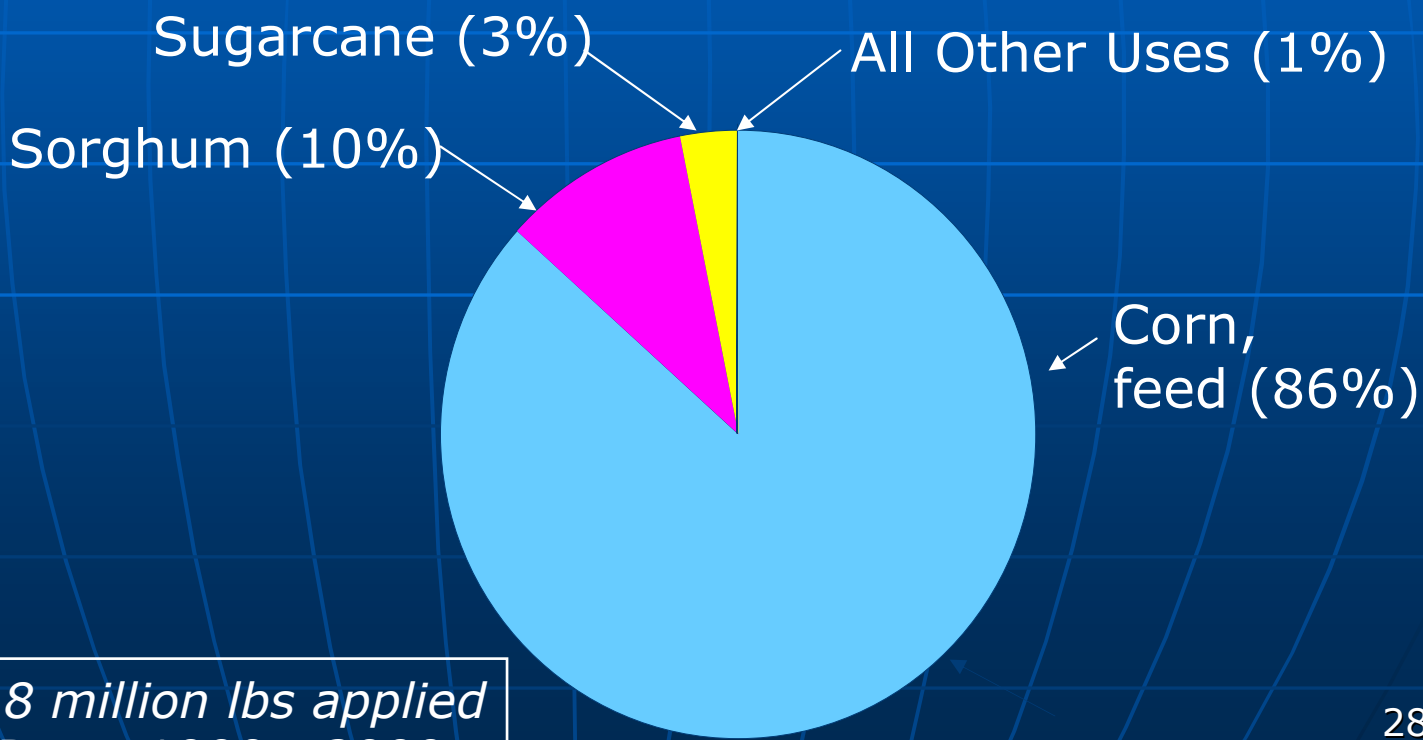


Crops	Total Pounds Applied	Percent National Use
corn	53, 796, 206	84. 13
sorghum	7, 339, 963	11. 48
sugar cane: sugar & seed	1, 711, 322	2. 68
pasture	518, 074	0. 81
sweet corn	444, 523	0. 70
sod	119, 182	0. 19
prosomillet	11, 937	0. 02
field and grass seed	6, 305	0. 01

Source: US Geological Survey: http://water.wr.usgs.gov/pnsp/use92/atrazin.html

Use Profile – Agricultural Markets

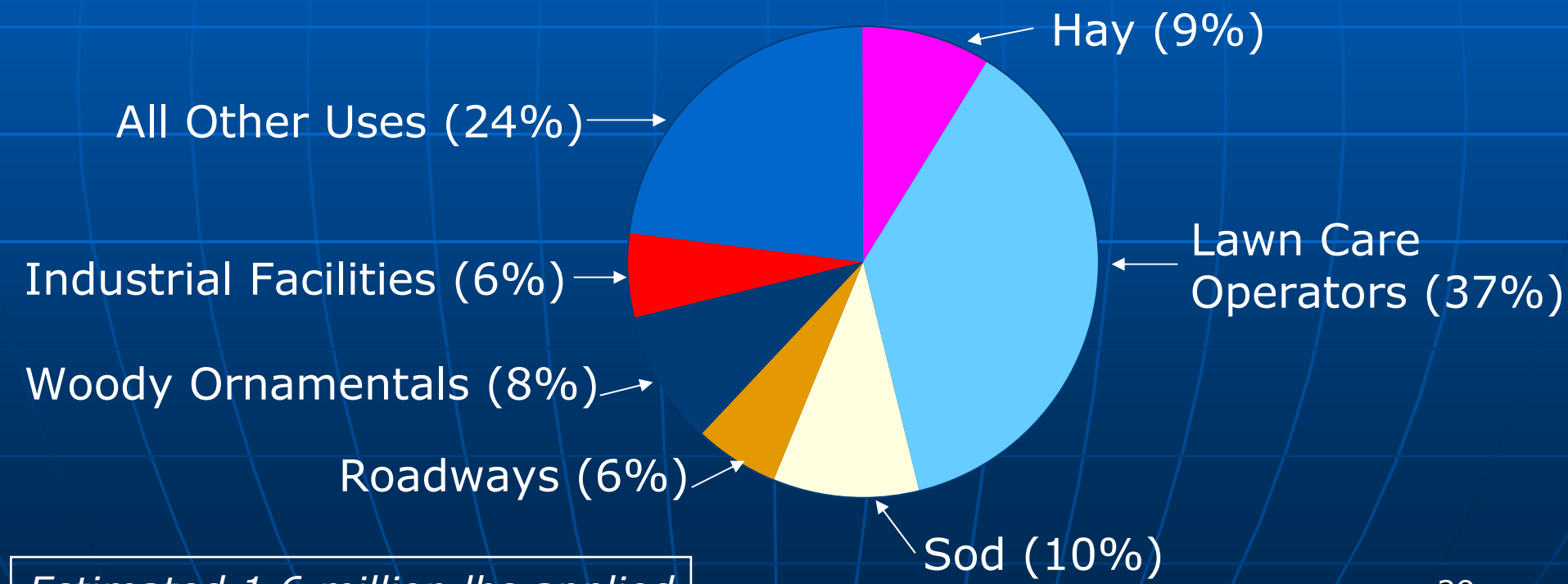
Atrazine Usage for Agricultural Food Uses As a % of Total Food Agricultural Pounds Applied In US Markets



Estimated 74.8 million lbs applied
Source: EPA Data, 1990 - 2000

Use Profile – Non-Food and Non-Agricultural Markets

Non-Food Atrazine Usage As a % of Total Non-Food Ag and Non-Ag Lbs Applied For US Markets



Estimated 1.6 million lbs applied
Source: EPA Data, 1990 - 2000

Use Profile

- Typical Agricultural-Food Acres Treated
  - Estimated 67.6 million crop acres treated annually
    - Corn, field: 88% of total acres treated
    - Sorghum: 9% of total acres treated
    - Sugarcane: <1% of total acres treated

- Major Uses by Estimated % Crop Treated
  - 5 crops with ≥50% Crop Treated (see Table)
    - Sugarcane,Field Corn, Sorghum, Sweet Corn-Fresh, Sweet Corn-Processed

Major Crop Use by Percent Crop Treated

Crop	Total Acres Treated (1,000)	Percent Crop Treated
Field Corn	59,500	75
Sorghum	6,500	59
Sugarcane	650	76
Sweet Corn, Processed	270	58
Sweet Corn, Fresh	110	50

Source: EPA, Average of 1990-2000 Data

Use Profile

- Sources of Use Data
  - USDA/NASS
  - National Center for Food and Agricultural Policy
  - California Department of Pesticide Regulation
  - Commodity/User Groups
  - US EPA Proprietary Databases
  - Website
    - http://www.epa.gov/trac/science/

Human Health Risk Assessment

Catherine Eiden
Senior Scientist
Health Effects Division

Road Map

Atrazine Facts

Toxic Effects

Dietary (Food) Assessment

Drinking Water Assessment

Residential Assessment

Aggregate Assessment

Occupational Assessment

Risk Assessments Conducted

- Dietary (food+ drinking water)
  - Acute
  - Intermediate-term
  - Chronic
- Residential
  - Short-Term
- Aggregate
  - Acute
  - Chronic
  - Short-Term
- Occupational
  - Short-Term
  - Intermediate-Term

Atrazine Facts

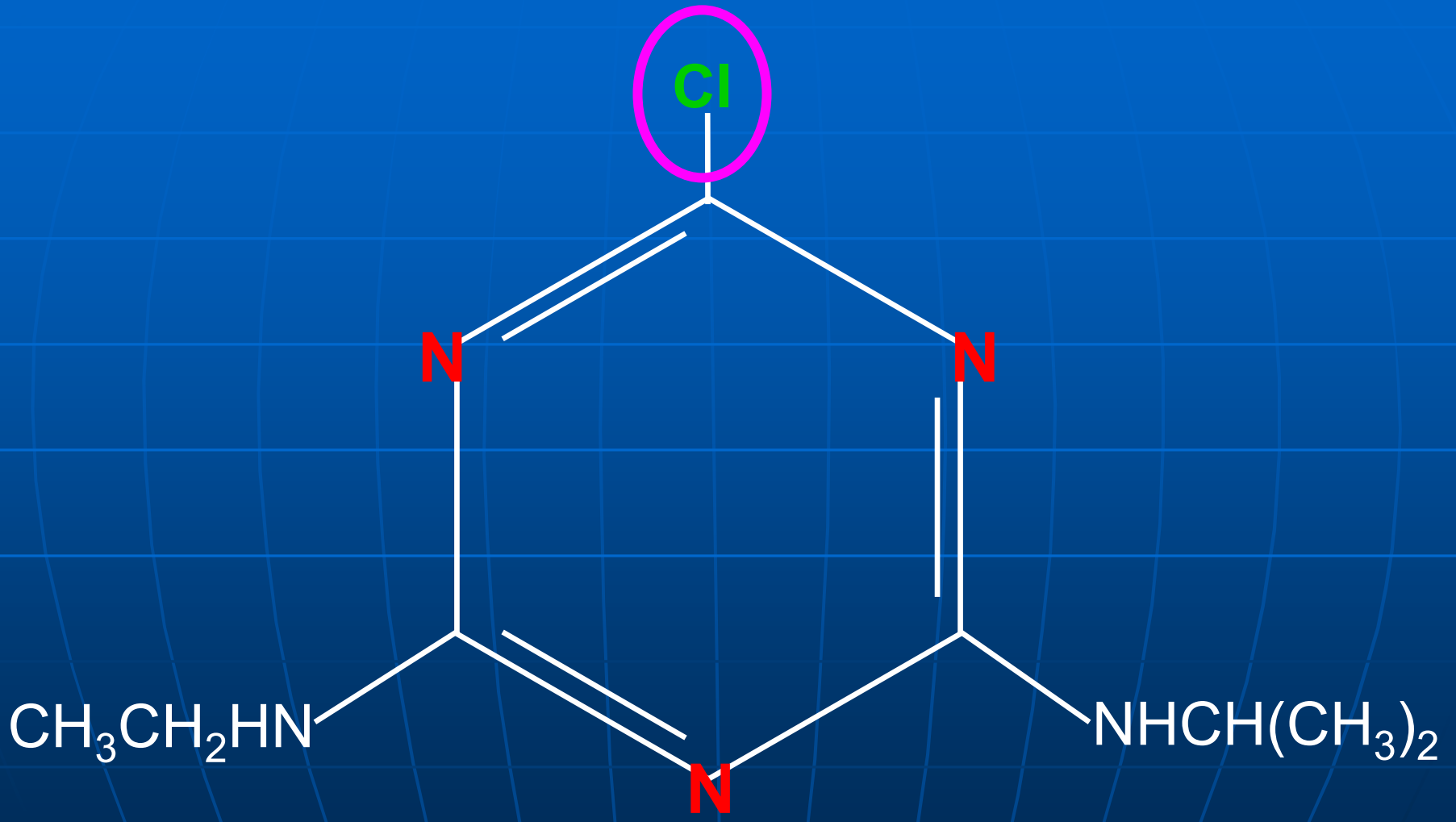
- **What is Atrazine?**
  - Triazine herbicide
  - Chlorinated ring structure
- **Three chlorinated metabolites**
  - The dominant metabolites found in animal tissues, and in soils and water
- **Four hydroxy metabolites**
  - The dominant metabolites found in plants

Chlorinated Metabolites

- Desethylated Atrazine (DEA)
- Desisopropyl Atrazine (DIA)
- Diaminochlorotriazine (DACT)

Toxicity = Parent

Chlorotriazines

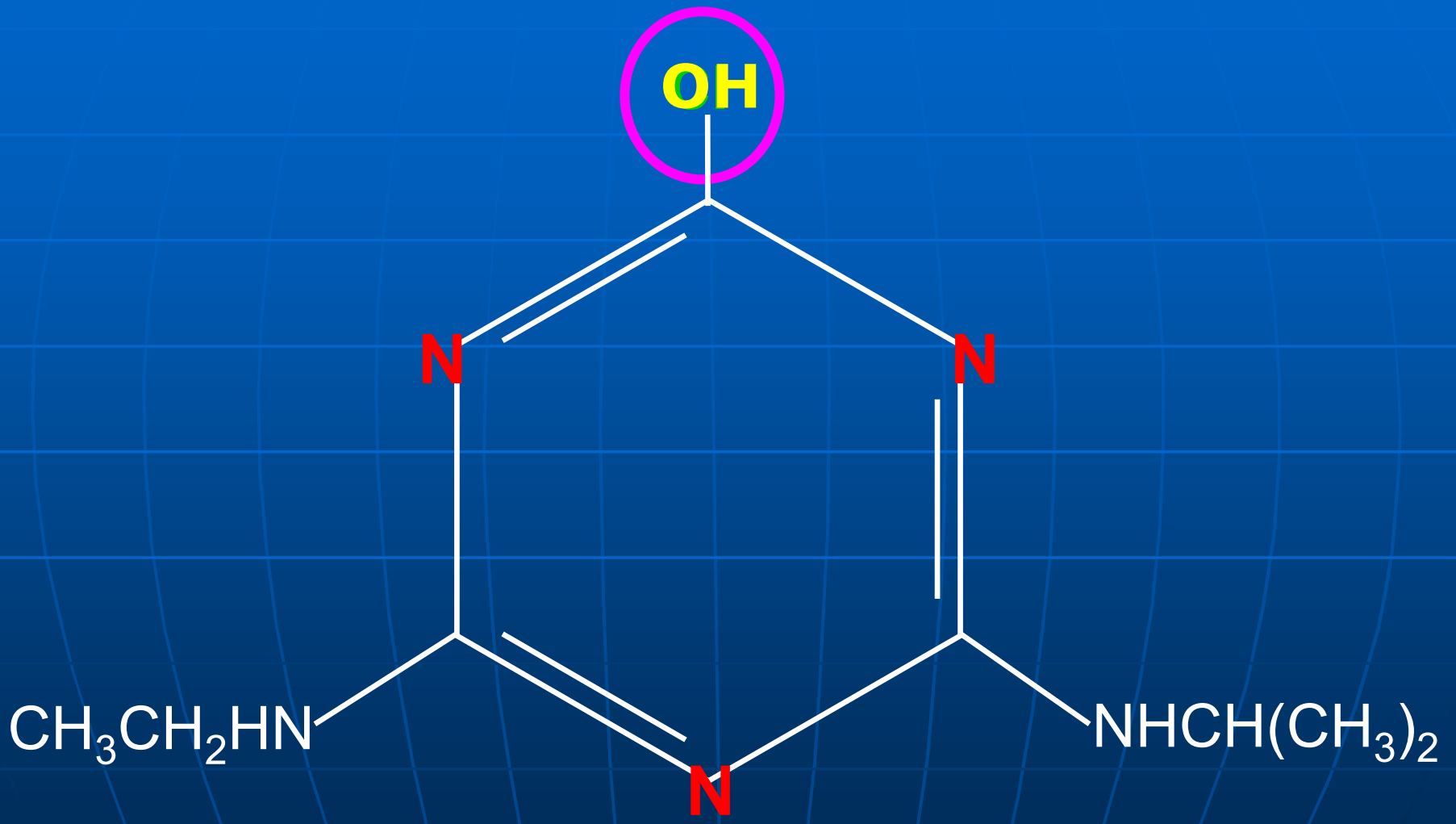


Hydroxy Metabolites

- Found predominately in plants
- Toxicity not equivalent to that of the parent

Toxicity ≠ Parent

Hydroxy Metabolites



Why Do We Care About Atrazine Metabolites?

- **Chlorinated**
  - Same toxicity as atrazine
  - Residues occur in food and water
  - Chlorotriazine risk assessment

- **Hydroxy**
  - Toxicity differs from atrazine
  - Residues occur in food
  - Separate dietary risk assessment

Road Map

Atrazine Facts

Toxic Effects

Effect Levels

- LOAEL (mg/kg/day)
  - **L**owest **O**bserved **A**dverse **E**ffect **L**evel

The lowest dose at which an "adverse" health effect is seen.

- NOAEL (mg/kg/day)
  - **N**o **O**bserved **A**dverse **E**ffect **L**evel

The dose at which no "adverse" health effect is seen (<LOAEL).

Risk Terms

- RfD (Reference dose)

  $RfD = NOAEL / UF$

  - Uncertainty Factor
    - 100x (10x intraspecies variation; 10x interspecies variability)

- MOE (Margin of Exposure)

  $MOE = NOAEL / Dose$

- PAD (Population Adjusted Dose)

  $PAD = RfD / FQPA\ SF$

  - FQPA Safety Factor

Exposure Durations Used in Risk Assessments

- Acute (1-day)
  - Dietary
    - Food and Water
- Short-Term (1-30 days)
  - Residential and occupational
- Intermediate-Term
  - 30 days to 6 months
  - Dietary, residential, and occupational
- Chronic (6 months to life-time)
  - Dietary

Endpoint for Acute Dietary Risk Assessment

- **Study Used**
  - Developmental toxicity studies in female rats and rabbits
- **Endpoint**
  - Delayed ossification (offspring) and decreased body weight gain (adult)
  - Relevant to females 13-50

Endpoint for Acute Dietary Risk Assessment

Dose

LOAEL = 70 mg/kg/day
NOAEL = 10 mg/kg/day
UF = 100
RfD = 0.1 mg/kg/day
FQPA SF = 10*
aPAD = 0.01 mg/kg/day

(10 applied to dietary risk assessments)

Endpoint for Chronic/Intermediate Risk Assessments

- **Study Used**
  - Special Study
    - Six-month Luteinizing Hormone (LH) surge study in rats

- **Endpoint**
  - Relevant biomarker for neuroendocrine effects
  - Attenuation of pre-ovulatory LH surge
  - Most sensitive endpoint in data set
  - Relevant to all populations
  - Effect seen after 4-5 months of dosing

Endpoint for Chronic/ Intermediate Risk Assessments

Dose

LOAEL = 3.65 mg/kg/day

NOAEL = 1.8 mg/kg/day

UF = 100

RfD = 0.018 mg/kg/day

FQPA SF = 10*

cPAD = 0.0018 mg/kg/day

(10* applied to dietary risk assessments)

Endpoint for Short–Term Risk Assessments

- **Study Used**
  - Special Study
    - Pubertal Assay (30-day) in developing male rats
- **Endpoint**
  - Delayed puberty
  - Relevant to all populations

Endpoint for Short–Term Risk Assessments

Dose

LOAEL = 12.5 mg/kg/day
NOAEL = 6.25 mg/kg/day
UF = 100
RfD = 0.063 mg/kg/day
FQPA SF = 3*
Target MOE=300

(3* applied to residential risk assessments, not occupational risk assessments)

Hydroxyatrazine: Endpoint for Chronic Risk Assessment

- **Study Used**
  - Combined toxicity and carcinogenicity study in rats
- **Endpoint**
  - Histological lesions in the kidneys
  - Relevant to all populations

Hydroxyatrazine: Endpoint for Chronic Risk Assessment

Dose

LOAEL = 7.75 mg/kg/day
NOAEL = 1.0 mg/kg/day
UF = 100
RfD = 0.01 mg/kg/day
FQPA SF = 1*
cPAD = 0.01 mg/kg/day

(1*applied to dietary risk assessment)

Atrazine Mode of Action and Derivation of the FQPA Safety Factor

Vicki Dellarco, Senior Science Advisor
Linda Taylor, Toxicologist
Health Effects Division

History: Atrazine Cancer Assessment

1987 – 1st Cancer Review

- Classified as possible human carcinogen

1988 – SAP Review

- Supported classification
- Recommended studies on hormonal mechanism

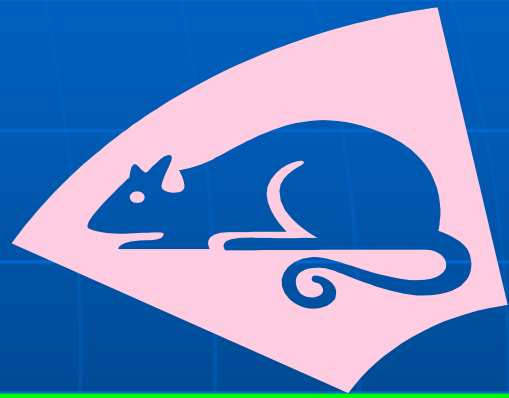
Since 1988

- Numerous studies on mode of action
  - Registrant, EPA, Literature

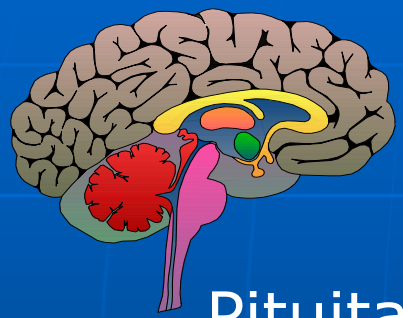
FIFRA SAP Meeting June 2000

- SAP Topic Areas
  - Cancer Mode of Action Analysis
  - Human Relevance
  - Children's Hazard

Atrazine Cancer Mode of Action in Female Rats



Hypothalamic Neurotransmitters/peptides



Pituitary Gland

↓LH

Ovary

Prolong secretion of estrogen

Mammary Gland Tumors

Cancer Mode of Action for Rat Tumor Findings

June 2000 SAP View

- Supported by Weight of Evidence
  - "The data strongly support the hypothesis that prolonged exposure to estrogen produced by the ovary is requisite for development of mammary tumors observed in these studies."
- No data suggest other plausible modes of action

Atrazine Human Cancer Concern

- SAP 2000- *"In summary, there are considerable differences between hypothalamic-pituitary-ovarian function in rats and humans, and the effects of aging on the function of the axis also is quite dissimilar. Therefore, it is unlikely that the mechanism by which atrazine induces mammary tumors in female SD rats could be operational in humans."*

EPA's Revised Cancer Classification for Atrazine

- **"Not Likely To Be Carcinogenic To Humans"** (Used 1999 EPA Interim Cancer Guidelines)
  - Tumors are female rat specific & only mammary gland
  - Mode of action does not support a human cancer concern
  - No other cancer modes of action supported by data
  - Consequently, no cancer risk assessment was conducted

EPA's Revised Cancer Classification for Atrazine

- A few epidemiologic studies suggest a possible association between atrazine (or triazine) exposure & certain cancers, but lack of multiple studies, internal inconsistencies, & confounding factors in these studies do not indicate a strong causal relationship.

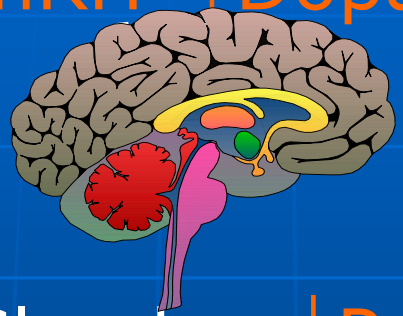
Neuroendocrine (CNS) Mode of Action

- Available data support the potential for reproductive and developmental effects as a consequence of hormonal imbalance after atrazine exposure
- Although SAP concluded that the cancer MOA described is relevant to the SD rat only, it also concluded that reproductive and developmental effects associated with atrazine exposure may occur across species, including humans

ATRAZINE

Hypothalamic Neurotransmitters/peptides

↓GnRH ↑Dopamine



Pituitary Gland -- ↓Prolactin, ↓LH

Gonads

Effects on Reproductive Function and Development

Effects on Reproductive & Developmental Processes

- Delayed puberty in males and females
- Disrupted ovarian cycling
- Prostatitis in male offspring
- Pregnancy outcome

Neuroendocrine Mode of Action

Children's Hazard

- SAP agreed that atrazine's neuroendocrine mode of action raises concerns for potential adverse sexual developmental effects in children:

  " Because of the rapid developmental brain changes …..the influence of atrazine on neurotransmitters in the hypothalamus and on GnRH may well have a differential, permanent effect on children." (SAP June 2000)

FQPA 10X Safety Factor

- January 2002 10X Guidance
  - *"DETERMINATION OF THE APPROPRIATE FQPA SAFETY FACTOR(S) IN TOLERANCE ASSESSMENT"* http://www.epa.gov/oppfead1/trac/science/#10-fold
- Three areas of analysis
  - Completeness of the Toxicity Data
  - Concern for Susceptibility (pre- & Postnatal Toxicity)
  - Completeness of the Exposure Data

Children's Hazard

Area of Analysis: Completeness of Toxicity Data

- Atrazine has been well studied:
  - All routinely required guidelines studies are available
  - Several special studies on atrazine's endocrine, reproductive, & developmental effects

Children's Hazard

Area of Analysis: Degree of Concern for Susceptibility

- Residual uncertainties
  - SAP 2000 "*Because of the rapid developmental brain changes alluded to above, the influence of atrazine on neurotransmitters in the hypothalamus and on GnRH may well have a differential, permanent effect on children.*
  - Early periods of development not evaluated with repeated dosing

Children's Risk

Area of Analysis: Completeness of Exposure Data

- Residual Uncertainties
  - Widespread exposure to Atrazine & its metabolites in drinking water
  - Limitations in the extent, frequency, & compounds tested for in the monitoring data
  - Significant uncertainties regarding whether all the populations with high-end exposure to Atrazine & its metabolites have been adequately assessed

FQPA Safety Factor
Food + Drinking Water Exposures

High degree of concern for susceptibility

Uncertainties associated with drinking water exposure

Residual concerns for neuroendocrine mode of action on the development of the young, and residual concerns with regard to drinking water exposures prevented the removal of the 10x default FQPA safety factor

FQPA Safety Factor Residential Exposures

High degree of concern for susceptibility

Protective conservative assumptions

Residual concerns for neuroendocrine mode of action on the development of the young and insignificance of drinking water exposures relative to residential exposure, resulted in the reduction of FQPA safety factor to 3X

Common Mechanism Determination

Artensie Flowers, Toxicologist
Alberto Protzel, Toxicologist
Health Effects Division

Common Mechanism Framework

- Conduct Initial Screening
  - Common toxic effect
  - Structural similarities
  - Similar mechanism of toxicity
- Examine Mechanistic Data
- Compare & Group

Common Toxicity Endpoints

- Attenuation of the LH surge
- Alteration of the estrous cycle
- Delayed puberty
- Altered pregnancy outcome

Weight-of-Evidence Approach: Final Common Mechanism Group

- Atrazine
- Simazine
- Propazine
- Common Chlorinated Metabolites

(*Cyanazine was not considered: no longer a registered pesticide)

Final Documents Can Be Found At:

- www.epa.gov/oppfead1/cb/csb_page/updates/triazine.htm
- Comment period closes June 2, 2002

Road Map

Atrazine Facts

Toxic Effects

Dietary (Food) Assessment

Basic Risk Equation

Risk = Hazard x Exposure

&

Exposure = Consumption x Residue

Risk Metrics

- % PAD = $\frac{\text{Exposure}}{\text{PAD}} \times 100$
- The PAD represents the target exposure we do not want to exceed
  - aPAD = 0.01 mg/kg/day
  - cPAD = 0.0018 mg/kg/day
- Therefore, risk estimates < 100% PAD are below levels of concern

Dietary Exposure/Risk

- Chlorotriazines
- Hydroxyatrazine

Dietary (Food Only) Risk Assessments for Chlorotriazines

- Acute
  - Risk assessment reflecting one-day dietary exposures to pesticide residues
- Relevant population
  - Female 13-50

- Chronic
  - Risk assessment reflecting longer-term exposures to pesticide residues
- Relevant populations
  - All

Consumption & Residue Data

- USDA's Continuing Survey of Food Intake by Individuals (CSFII), 1989-92 report
- Residue Data
  - Field trials
  - Metabolism study data
  - Monitoring data
    - USDA PDP data
    - FDA data
    - FSIS data

Food Residues

- Most food had non-detectable levels of chlorotriazines

Acute/Chronic Dietary Risk Estimate for Chlorotriazines

- Risk estimate at 99.9th percentile of exposure
  - <1% aPAD (females 13-50)
- Risk estimate based on average exposure
  - <1% cPAD (all populations)
- Exposure in food is insignificant

Dietary Risk Assessment for Hydroxyatrazine

- Chronic
  - Risk assessment reflecting longer-term exposures to pesticide residues
- Relevant Populations
  - All
- Risk estimate based on average exposure
  - <1% cPAD (all populations)

* No acute endpoint/No acute assessment

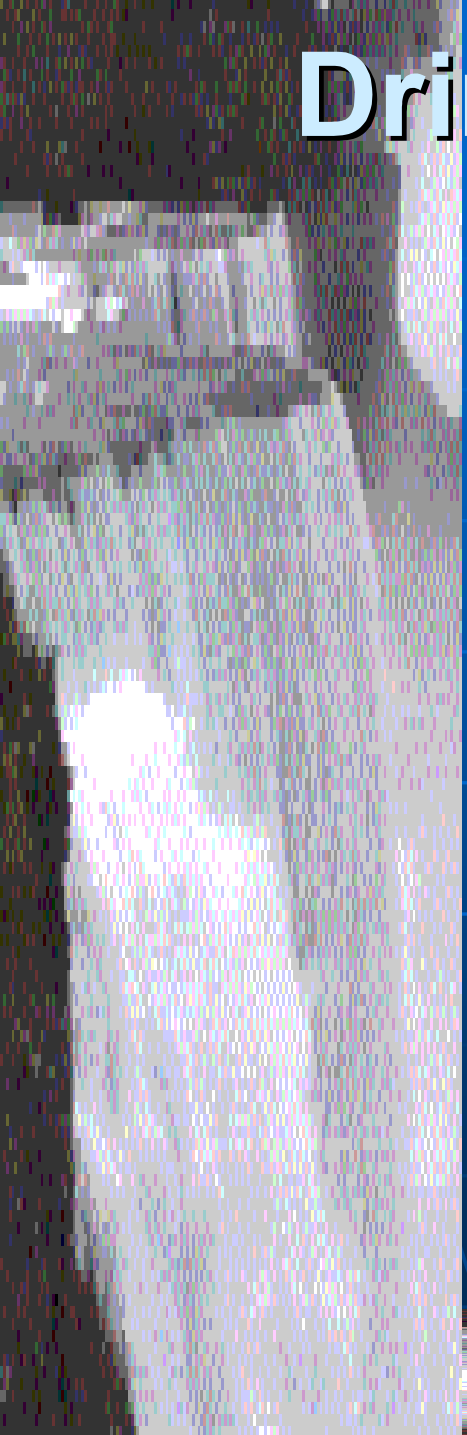
Road Map

Atrazine Facts

Toxic Effects

Dietary (Food) Assessment

Drinking Water Assessment



Drinking Water Exposure & Risk Assessments

- Fate and occurrence
- Risk assessments conducted
- Drinking water sources
- Monitoring programs
- Exposure methodology
- Risk estimates

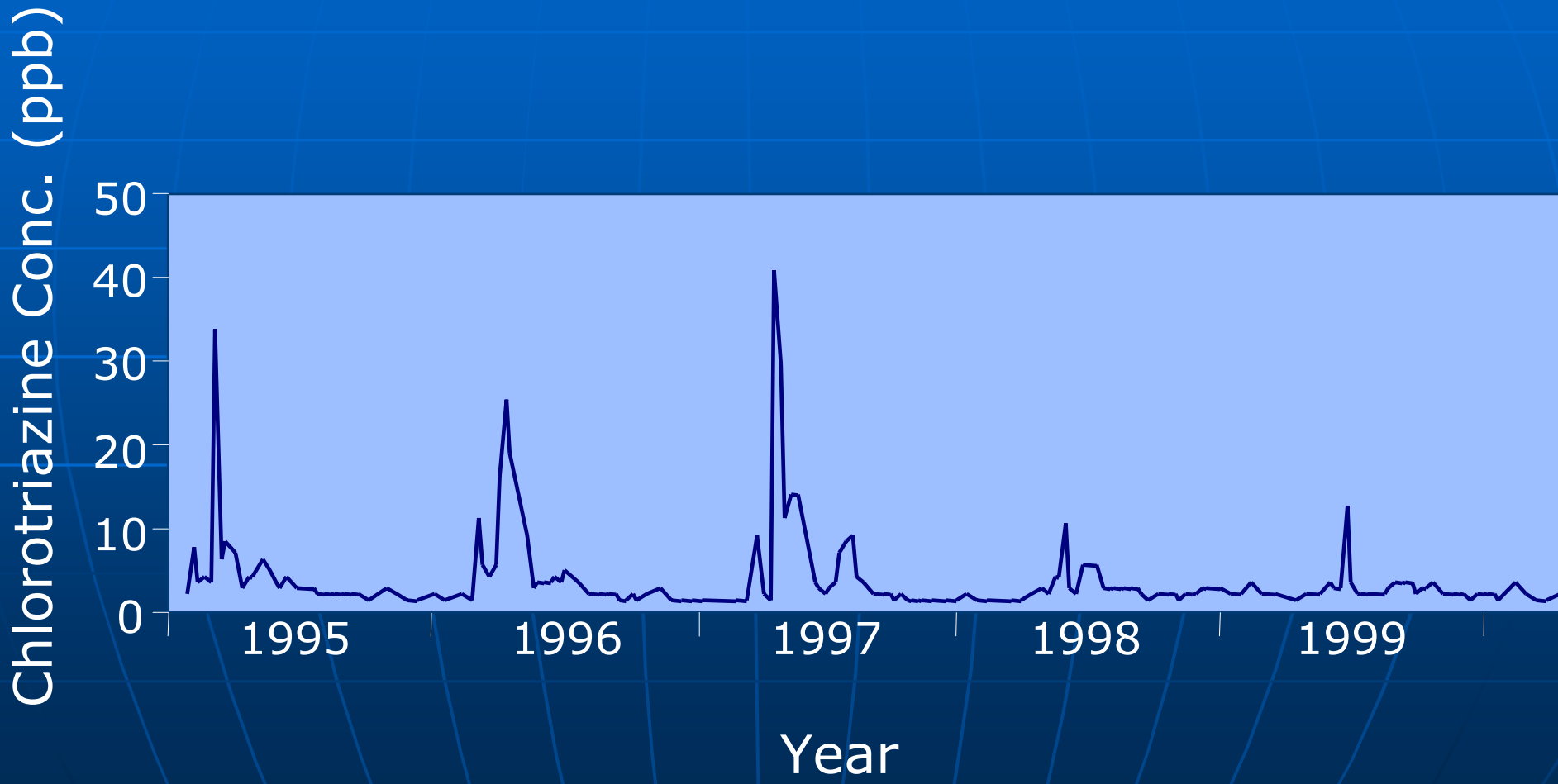
Points to Keep in Mind

- Community Water Systems (CWS)
  - Groundwater
    - Not significantly impacted
  - Surface Water
    - Select systems impacted
- Rural Wells
  - Some wells impacted in atrazine use areas

Fate & Occurrence

- Persistent and mobile
- Widely detected in ground and surface waters
- MCL = 3ppb for atrazine
- Seasonal pulses generally occur in the spring in surface water
- Hydroxyatrazine not expected to widely occur at detectable levels in drinking water

Typical Seasonal Pulses
(Surface Water)



Drinking Water Risk Assessments for Chlorotriazines

- Acute
  - Reflecting estimated maximum one-day exposures for CWS and rural wells
- Chronic
  - Reflecting estimated long-term average exposures for CWS and rural wells
- Intermediate-term
  - Reflecting estimated average seasonal exposures for select CWS using surface water

Sources of Drinking Water Considered in Risk Assessments

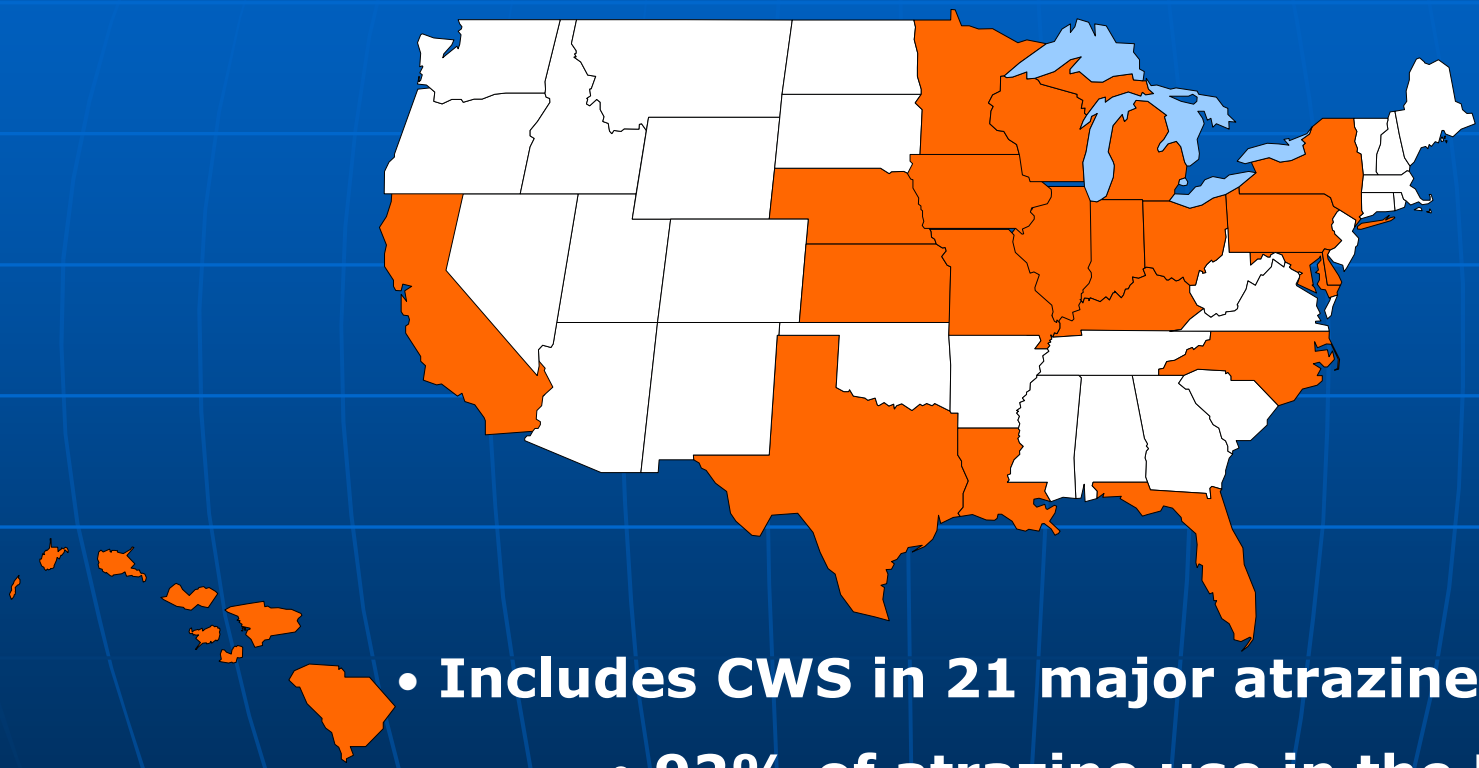
- CWS regulated under the Safe Drinking Water Act (SDWA)
  - Groundwater
  - Surface water
- Rural wells in atrazine use areas

Available Monitoring Databases Used in Risk Assessments

- Drinking water databases
  - Compliance monitoring data collected under SDWA (PLEX)
    - Population Linked EXposure database
  - Acetochlor registration partnership (ARP)
    - Sponsored by consortium of registrants
  - Voluntary monitoring program
  - Synoptic groundwater survey
  - Rural well survey

Syngenta

PLEX Monitoring Database

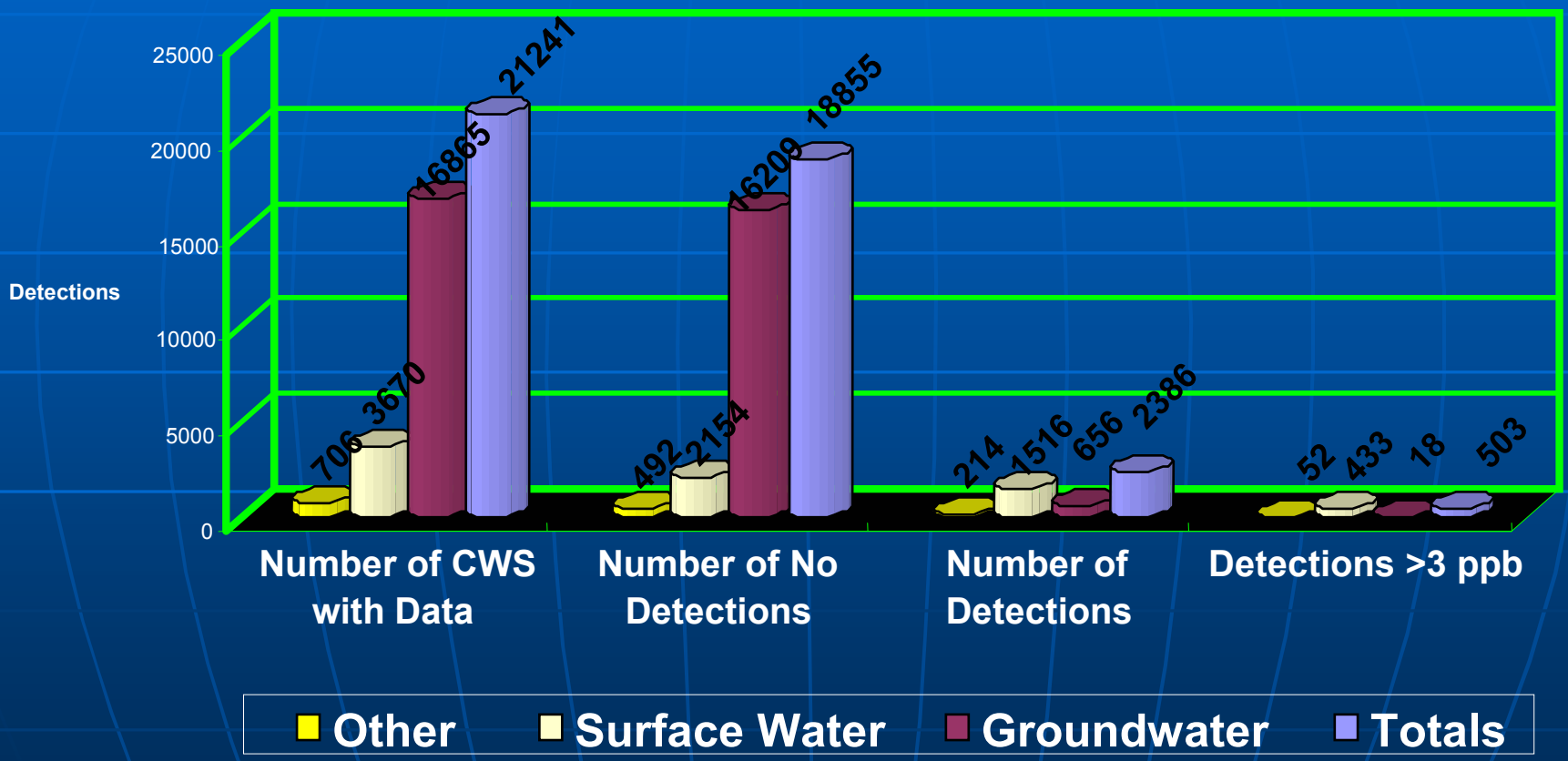


- Includes CWS in 21 major atrazine use states
- 92% of atrazine use in the U.S.
- 120 million people

PLEX (1993-2000) - CWS

- Groundwater and surface water
- >21,000 CWS in 21 major use states
- Quarterly sampling
- Atrazine only, does not include metabolites

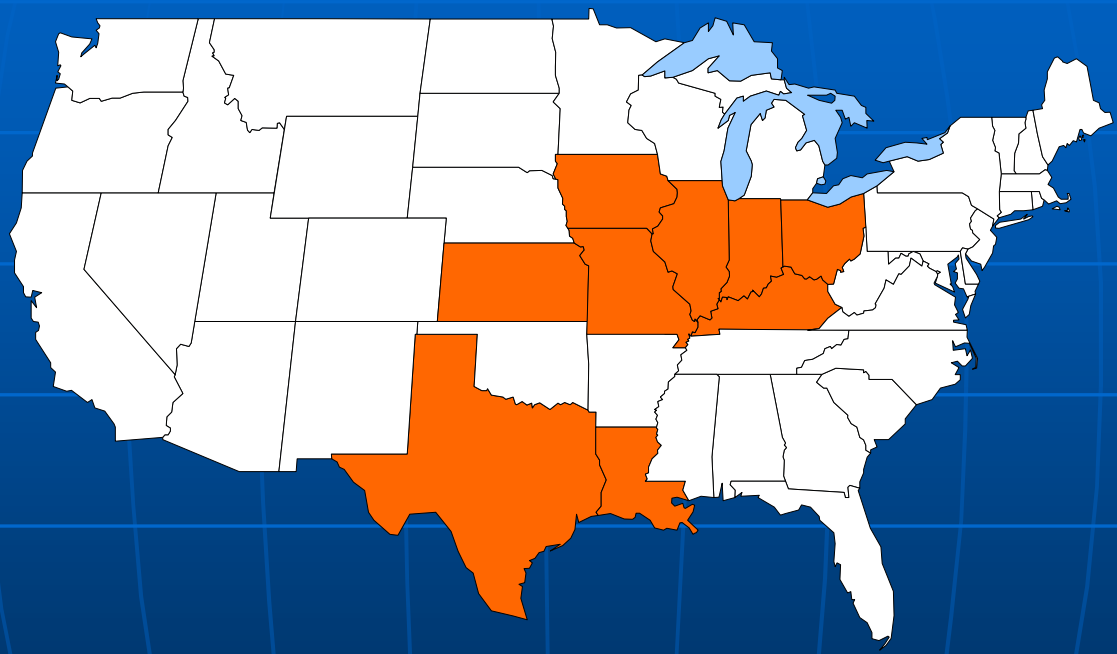
PLEX DATA FOR ATRAZINE
(JANUARY 1993- DECEMBER 1998)



Synoptic Survey (May-October 2000) - CWS

- Groundwater
- 204 CWS with prior detections sampled
- 235 CWS without prior detections
- Total of 14,500 ground water CWS represented
- Monitored for chlorotriazines
- Maximum concentration ~10.5 ppb

Voluntary Monitoring Program (VMP)



- **Includes 9 states with CWS using surface water with concentrations of atrazine approaching the MCL (3 ppb)**
- **Sub-set of the PLEX database**

VMP (1993-2001) - CWS

- Surface water
- 100 CWS in 9 states
- Weekly sampling from April through July
  - biweekly the remainder of the year
- Maximum atrazine concentration 63 ppb
- Chlorinated metabolites
  - Subset of 17 CWS
  - Monitored for one year
  - Estimated maximum concentration 89 ppb

Acetochlor Registration Partnership (ARP; 1995-1998) - CWS

- Surface water
- 179 CWS in ~10 states
- Biweekly and monthly sampling
- Maximum atrazine concentration 50 ppb
- Atrazine only, does not include metabolites

Rural Well Survey (1992 – 1994)

- Groundwater
- 1505 individual drinking water wells in use areas across 19 states
- Sampled once or twice for atrazine, 3 chlorinated metabolites, and hydroxy triazines
- Maximum concentration of 18 ppb

Chlorinated & Hydroxy Metabolites

- Linear regression to estimate chlorinated metabolites in surface water CWS
- CWS Synoptic Survey (groundwater CWS) included chlorotriazines
- Rural Well Survey included chlorotriazines and hydroxyatrazine

Monitoring Data Characterization

- Most extensive monitoring database for a pesticide in drinking water

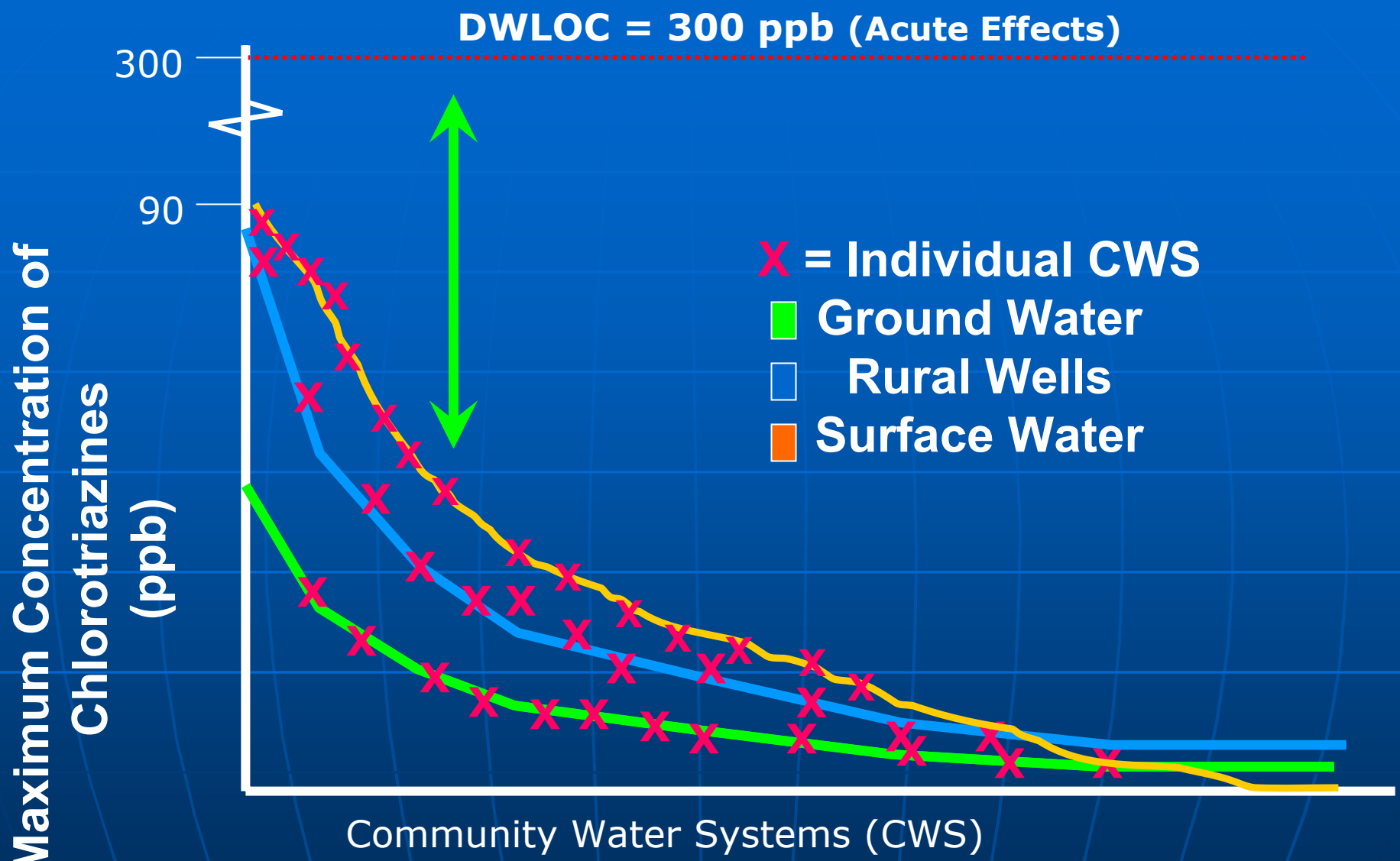
- Uncertainties
  - Frequency of monitoring under SDWA
  - One or two samples taken per rural well
  - Limited data on chlorinated metabolites

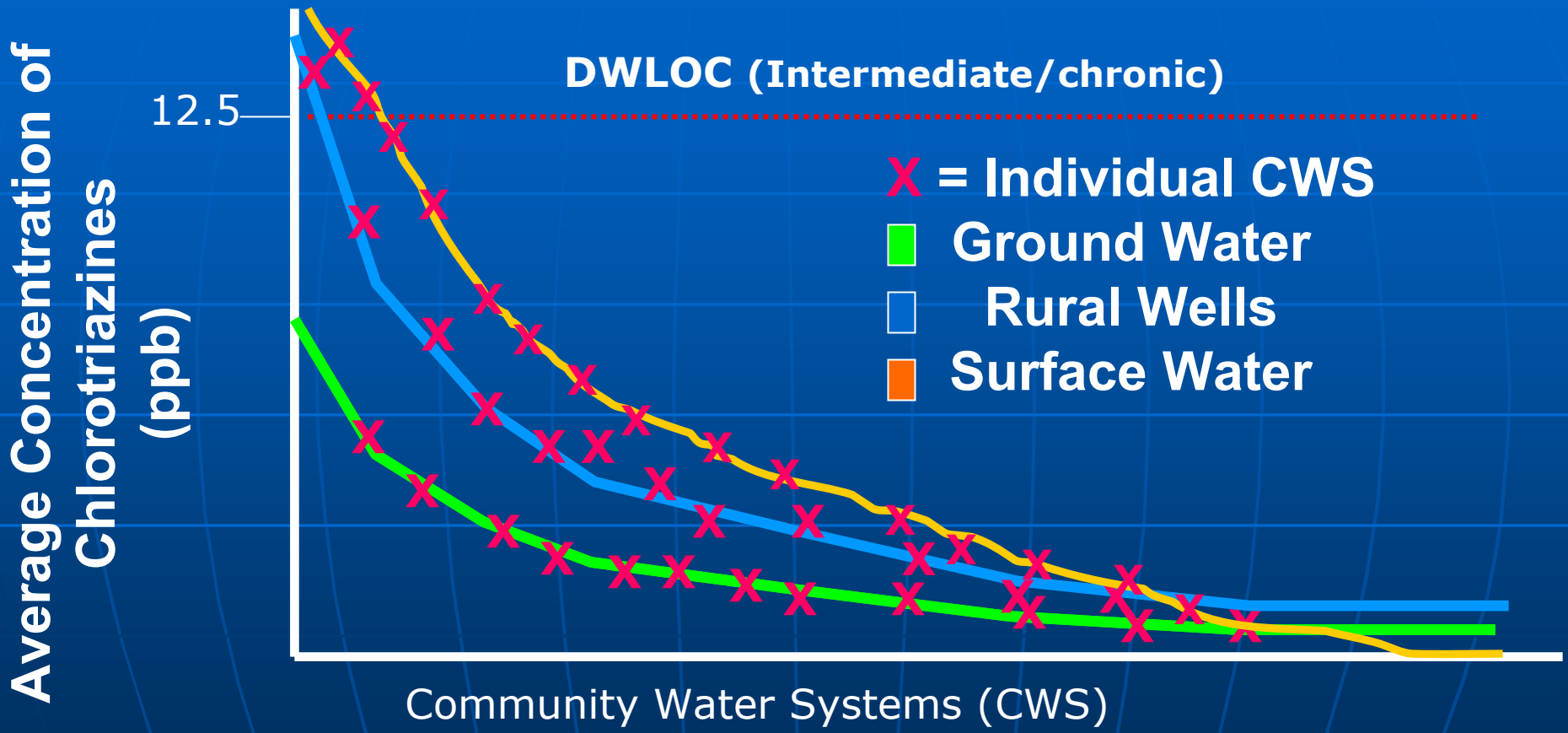
Exposure Methodologies

- Screening-Level Assessments
- Probabilistic Assessments
- Finished Water (water that has been treated)
- Includes Chlorotriazines

Exposure Methodology: Screening-Level Assessment

- DWLOCs approach
  - Considers food exposure
- DWLOCs for each population subgroup compared to:
  - Maximum
  - Annual average
  - Seasonal average (where possible)


DWLOC = 300 ppb (Acute Effects)
300
90
Maximum Concentration of Chlorotriazines (ppb)
X = Individual CWS
Ground Water
Rural Wells
Surface Water
Community Water Systems (CWS)


Average Concentration of Chlorotriazines (ppb)
12.5
DWLOC (Intermediate/chronic)
X = Individual CWS
Ground Water
Rural Wells
Surface Water
Community Water Systems (CWS)

Results of the Screening Level Assessment

- Acute
  - Did not exceed DWLOCs in any CWS or well assessed
- Intermediate-term and chronic
  - Groundwater CWS did not exceed DWLOCs
  - ~30 surface water CWS did exceed DWLOCs
  - ~ 8 rural wells did exceed DWLOCs

Results of the Screening Level Assessment

- ~30 CWS exceeding DWLOCs were identified for probabilistic assessments
- Insufficient data for probabilistic analysis of the 8 rural wells

Probabilistic Assessment

- CWS-specific assessment
  - PLEX, VMP, ARP combined for a specific CWS
- Combines distribution of:
  - Residue data
  - Water consumption (CSFII)
  - Body weights (CSFII)

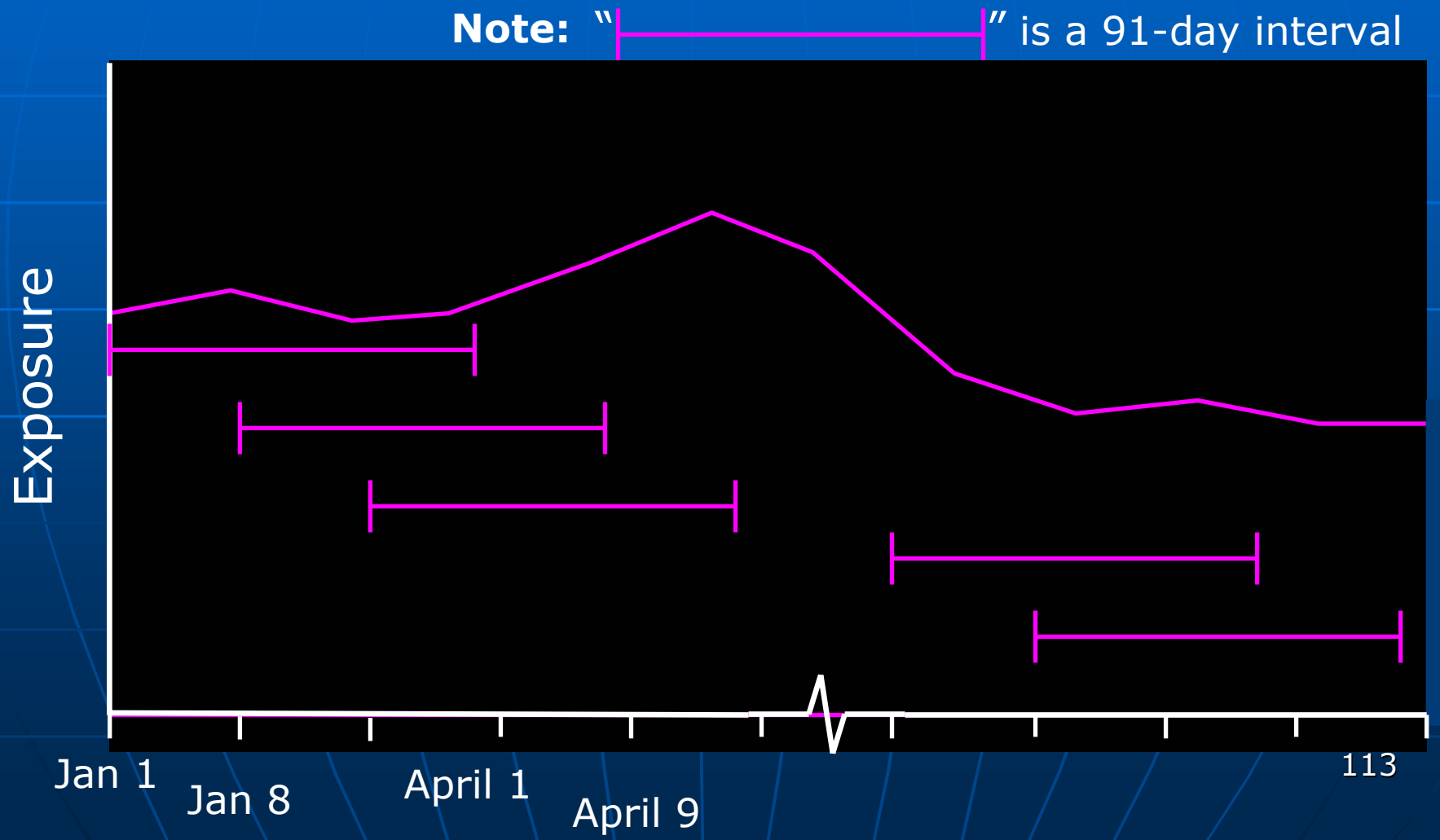
Probabilistic Assessment

- Intermediate-Term Time Frame
  - 91-day rolling average
- Exposure estimates @ 99.9th, 99th, & 95th percentiles compared to cPAD (0.0018 mg/kg/day) to estimate risk
- Risk estimate > 100% cPAD

Rolling Time-Frame Approach

- Average exposures over consecutive multiple days are calculated for each individual
  - e.g., January 1st - April 1st, …January 8th - April 9th
- Periods of Interest: 52 sets of 91 consecutive day intervals throughout year, offset by 1 week

Example of a 91-Day Rolling Time Frame



Probabilistic Assessment

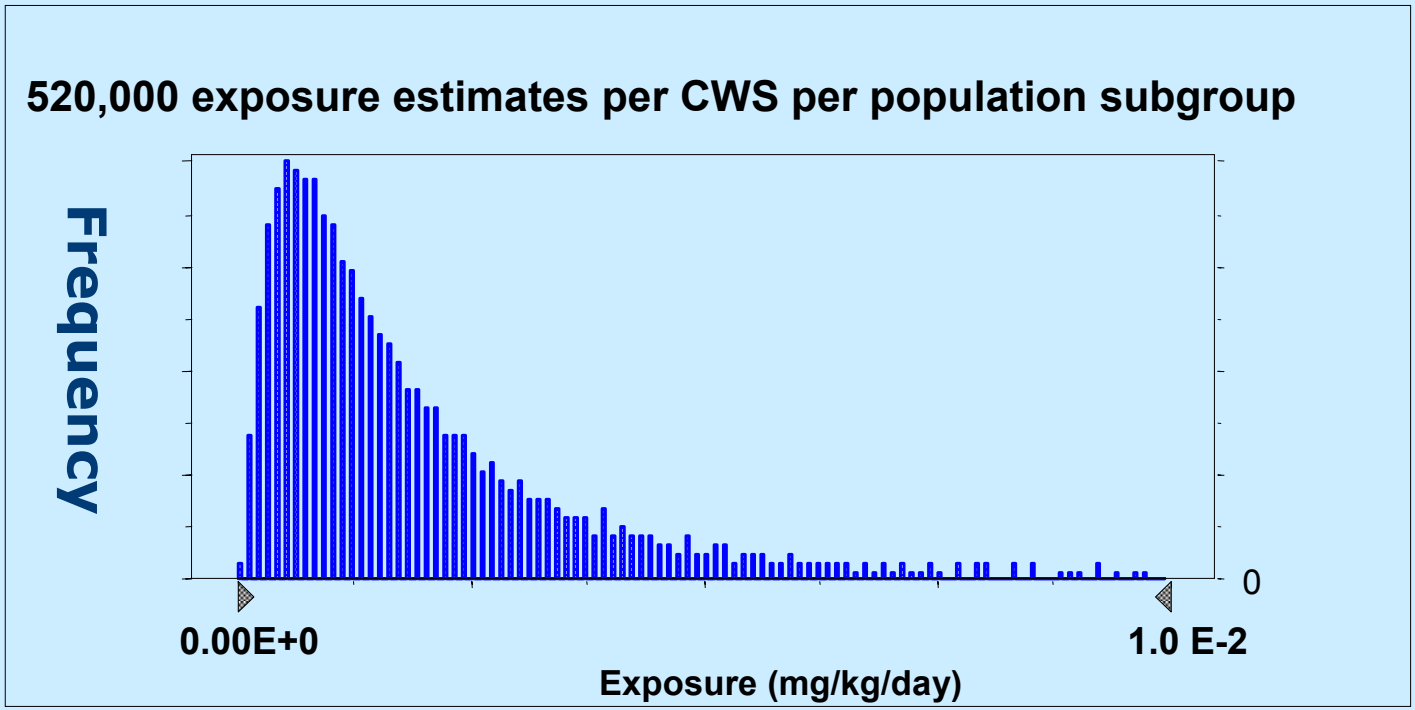
- Select CWS for analysis (CWS in IL)
- Select year of monitoring data randomly from 1993-2001 (1995)
- Select individuals from a population subgroup
- Select individual consumption record from CSFII available 2-day records

Probabilistic Assessment (cont.)

- Calculate individual's daily exposure by pairing one of two available water consumption value with water concentration value for January 1st (1995)
- Repeat with same individual, pairing water consumption with concentration value for January 2nd (1995)
- Continue through April 1st to estimate daily water exposures over 91 consecutive days for January 1st through April 1st (1995)
- Average daily exposures over consecutive 91-day period
- This distribution of 91-day average exposures are compared to the cPAD

Probabilistic Assessment

Distribution of rolling 91 day average exposures to chlorotriazines for infants



Results of Intermediate-Term Probabilistic Assessment

Exposure Percentile	**95th**	**99th**	**99.9th**
Number of CWS	8	22	25
% cPAD	100-240	100-420	100-670

Summary of Intermediate–Term and Chronic Risk Estimates

- Groundwater CWS
  - Screening level DWLOCs not exceeded
- Surface Water CWS
  - Screening level/probabilistic levels of concern exceeded for 29 systems
- Rural Wells
  - Screening level DWLOCs exceeded for 8/1505 rural wells

Summary of Intermediate-Term and Chronic Risk Estimates

- OPP has concern for 29 CWS using surface water
  - Serving ~ 180,000 people
  - Exposures for children (including infants) above levels of concern in 1, 2, or 3 years between 1993 – 2001
  - Exposures also of concern in some systems for adults
- Additional 52 CWS identified for monitoring

Overall Summary for Drinking Water Risks

- 33% of CWS assessed representing 92% of atrazine use
- Acute exposures do not exceed levels of concern
- Intermediate/Chronic exposures exceed levels of concern for some surface water CWS and rural wells
- Uncertainties associated with risk assessments

Road Map

Atrazine Facts

Toxic Effects

Dietary (Food) Assessment

Drinking Water Assessment

Residential Assessment

Residential, Aggregate, and Occupational Risk Assessments

Gary Bangs
Environmental Specialist
Health Effects Division

Atrazine Residential Risk Assessment

Gary Bangs, Environmental Specialist
Health Effects Division

Atrazine Residential Risk Assessment

- Risk Estimates of Concern:
  - Handler: Applying to ½ acre with Belly Grinder
  - Post-application: Adult and Child High Contact after Spray Application
  - Hand-to-Mouth: Spray Residue on Turf

Atrazine Residential Risk Assessment

- Residential (handler and postapplication)
  - Homeowners who mix, load and apply pesticides
  - Adults and children working and playing on treated lawns and turf
- Recreational (postapplication)
  - Golfers playing on treated golf courses
  - Adults and children playing on treated recreational turf (e.g., parks, playgrounds)

Atrazine Residential Risk Assessment

- Data Sources: Handlers
  - ORETF Studies
  - PHED Studies
- Data Sources: Postapplication
  - Granular Hand-Press Study
  - TTR Studies:
    - Granular
    - Liquid

Atrazine Residential Risk Assessment

Short-term Toxicity Endpoints

NOAEL [All Exposure Routes]:	6.25 mg/kg/day
Dermal Absorption:	6%
MOE (10 x 10 x 3x UF):	> 300

Atrazine Residential Risk Assessment

Handler Exposure and Risk Calculations

$$\text{Dose} = \frac{(\text{Unit Exposure}) \times (\text{Amount Handled}) \times (\text{Absorption})}{\text{Body Weight}}$$

Unit Exposure. *Derived from Residential SOPs unless chemical-specific data are available.*

Amount Handled. *Label information (e.g., application rate and frequency); standard assumptions on number of days worked, etc.*

Absorption. *6% based on dermal absorption study*

Body Weight. *Standard value: 70 kg for adults*

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

Atrazine Residential Risk Assessment

Residential Handler Risk Estimates

- MOE > 300:
  - Push-spreader, Hose-end Spray, Backpack, and Low-pressure Hand Wand
- MOE < 300:
  - Belly-grinder on ½ acre lawn MOE 65
  - Spot-treatment by belly grinder MOE >300

Atrazine Residential Risk Assessment

Dermal Postapplication Risk Estimates

$$\text{Dose} = \frac{\text{DFR} \times \text{Transfer Coefficient} \times \text{Hrs Worked} \times \text{Absorption}}{\text{Body Weight (kg)}}$$

DFR. *Measured in a study. This is chemical-specific. There is a Task Force generating data.*

Transfer Coefficient. *Standard values for a number of activities. When actual data are available, this is calculated specifically.*

Hrs Worked. *Standard value.*

Absorption. *6% based on dermal absorption;*

Body Weight. *Standard value: 70 kg for males; 60 for females*

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

Atrazine Residential Risk Assessment

Dermal Postapplication Risk Estimates

- MOE > 300:
  - Adults working, playing, golfing, and children playing on dry turf treated by spray or granular application
- MOE < 300:
  - Adults or children engaged in high-contact activities (i.e., play) on damp turf after spray treatment

Atrazine Residential Risk Assessment

Non-Dietary (Incidental) Oral Exposure

- Revised Residential Standard Operating Procedures (SOPs)
  - Hand-to-Mouth
  - Object-to-Mouth
  - Soil Ingestion
- All 3 exposure pathways aggregated

Atrazine Residential Risk Assessment

Non-Dietary (Incidental) Oral Exposure

- Risk Estimates:
- MOEs > 300:
  - Hand-to-Mouth, Object-to-Mouth, Soil Ingestion after granular application
- MOEs < 300:
  - Hand-to-Mouth after spray application

Residential Risk Assessment

- Data Quality
  - Only granular hand-mouth estimate based on granular hand press study; SOPs used for spray-applied residue
  - Limited behavioral data available so combination macro/microactivity approach

Road Map

Atrazine Facts

Toxic Effects

Dietary (Food) Assessment

Drinking Water Assessment

Residential Assessment

Aggregate Assessment

Summary of Aggregate Risk Assessments Conducted for Under FQPA

- Acute dietary (1-day)
  - Aggregates 1-day food + drinking water exposures
- Chronic dietary (6 months to lifetime)
  - Aggregates long-term average food + drinking water exposures

Summary of Aggregate Risk Assessments Conducted for Under FQPA

- Intermediate-term (30 days to 6 months)
  - aggregates average food + drinking water exposures
- Short-term (1 to 30 days)
  - Aggregates average food + drinking water + screening level residential exposures

Results of Aggregate Risk Assessments

- Acute
  - Does not exceed level of concern
    - Same as acute drinking water assessment
    - Food exposures insignificant
- Chronic & Intermediate-Term
  - Some scenarios exceed levels of concern
    - Same as drinking water risks
    - Food exposures insignificant

Results of Aggregate Risk Assessments

- Short-term –
  - Screening-level assessments for liquid & granular formulations result in:
    - concern for adults applying atrazine by belly-grinder
    - concern for adults and children playing on spray-treated turf immediately after application while turf is wet
    - concern for children mouthing hands while on spray-treated turf immediately after application while turf is wet

Road Map

Atrazine Facts

Toxic Effects

Dietary (Food) Assessment

Drinking Water Assessment

Residential Assessment

Aggregate Assessment

Occupational Assessment

Atrazine Occupational Risk Assessment

Gary Bangs, Certified Industrial Hygienist
Health Effects Division

Atrazine Occupational Risk Assessment

Overview

- No concern for short-term handler exposure, with protective equipment or engineering controls
- Risk Estimates of Concern:
  - Intermediate-term handlers of large quantities of atrazine [i.e., to treat large acreage]
  - Postapplication scouting sugarcane

Atrazine Occupational Risk Assessment

- Data Sources:
  - Registered labels:
    - application rates and equipment
  - Use information:
    - cultural patterns (who and how much)
    - duration of exposure (short- or intermediate-term)
  - Standard values
    - e.g., daily acreage

Atrazine Occupational Risk Assessment

- Data Sources:
  - Chemical-specific exposure studies
  - Pesticide Handlers Exposure Database (PHED)
  - Outdoor Residential Exposure Task Force (ORETF)
  - Helix study data: fertilizer admixture surrogate

Atrazine Occupational Risk Assessment

- Atrazine-specific handler studies:
  - Large-scale (n=100) biomonitoring study of mixing/loading and applying to corn; consistency and quality issues
  - Passive dosimetry + biomonitoring study of mixer/loader/tenders and mixer/loader/applicators on corn
  - Lawn care operator study
  - Study of Syngenta + PHED combined handler exposures

Atrazine Occupational Risk Assessment

- The Handler Risk Assessment Is Based On:
  - Task (e.g., mixing/loading, spraying)
  - Formulation and application equipment (e.g., dry flowable, groundboom)
  - Unit exposure (mg ai/lb ai handled)
  - Amount of pesticide handled
  - Levels of protection (e.g., personal protective equipment and engineering controls)
  - NOAEL for various routes of exposure (mg/kg/day)

Atrazine Occupational Risk Assessment

Toxicity Endpoints

- Short-term 6.25 mg/kg/day
  - all exposure routes
- Dermal absorption 6%
- Intermediate-term 1.8 mg/kg/day
  - all exposure routes
- MOE [10 x 10] > 100

Atrazine Occupational Risk Assessment

Handler Exposure and Risk Calculations

$$\text{Dose} = \frac{(\text{Unit Exposure}) \times (\text{Amount Handled}) \times (\text{Absorption})}{\text{Body Weight}}$$

Unit Exposure *Derived from PHED and ORETF unless chemical-specific data are available.*

Amount Handled *Label information (e.g., application rate and frequency); standard assumptions on number of days worked, etc.*

Absorption *6% based on dermal absorption study*

Body Weight *Standard value: ST: 70 kg adults: IT: 60 kg females*

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

Atrazine Occupational Risk Assessment

- Handlers
  - Professional pesticide applicators and individual farmers/growers who mix, load and apply pesticides; flaggers for aerial application
  - Turf management professionals (golf courses)

Atrazine Occupational Risk Assessment

- Postapplication Workers
  - Workers who scout, irrigate, cultivate (weed/hoe), stake/tie, transplant, harvest (by hand or mechanically)
  - Turf management professionals who perform tasks after pesticide application (golf courses)

Atrazine Occupational Risk Assessment

- Supported atrazine Uses:
  - Four formulations; 174 active labels
  - Assessments conducted for use on:
    - Field crops
    - Tree crops
    - Turf: sod farms, residential, recreational, golf course

Atrazine Occupational Risk Assessment

- Supported Atrazine Uses:
  - Applied by:
    - Air
    - Airblast sprayer
    - Backpack sprayer
    - Belly grinder
    - Groundboom
    - Handgun (hydraulic sprayer)
    - –High-pressure sprayer
    - –Low-pressure sprayer (handwand)
    - –Right-of-Way Sprayer
    - –Spreaders (push-type & tractor-drawn)
- Generally applied at rate 2 lbs ai per acre per crop cycle, up to 4 lbs ai per application on sugarcane, macadamia nuts, conifers & sod

Atrazine Occupational Risk Assessment

Current Agricultural Labels Require:

- Long-sleeved shirt
- Long pants
- Shoes, plus socks
- Gloves (chemically-resistant, waterproof)
- Protective eyewear for mixer/loaders

Atrazine Occupational Risk Assessment

Handler Risks of Concern:

- Short-term exposure scenarios:
  - 1/2 of concern without gloves
  - 13% of concern with gloves
  - Only fertilizer admixture with PPE or Engineering Control
- Intermediate-term exposure scenarios:
  - 1/3 of concern even with maximum PPE
  - 15% of concern with engineering controls

Atrazine Occupational Risk Assessment

Postapplication Worker Assessment

Data Sources:

- DFR study on corn (Midwest states)
- TTR studies on turfgrass:
  - Granular: GA, FL
    - Non-irrigated, irrigated
  - Liquid: GA, NC

Atrazine Occupational Risk Assessment

Postapplication Worker Assessment

- Re-entry exposure assessed using corn residue study data:
  - Corn, sorghum, sugarcane, trees
- Re-entry exposure assessed using turf residue study data:
  - Sod farms, golf courses

Atrazine Occupational Risk Assessment

Postapplication Worker Exposure and Risk Calculations

$$\text{Dose} = \frac{\text{DFR} \times \text{Transfer Coefficient} \times \text{Hrs Worked} \times \text{Absorption}}{\text{Body Weight (kg)}}$$

DFR. *Measured in a study. This is chemical-specific. There is a Task Force generating data.*

Transfer Coefficient. *Standard values for a number of activities. When actual data are available, this is calculated specifically.*

Hrs Worked. *Standard value.*

Absorption. *6% based on dermal absorption;*

Body Weight. *Standard value: ST: 70 kg adults; IT: 60 kg females*

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

Atrazine Occupational Risk Assessment

Postapplication Worker Risks of Concern:

- Short-term exposure scenarios:
  - Scouting sugar cane
- Intermediate-term exposure scenarios:
  - No scenarios of concern

Atrazine Occupational Risk Assessment

- Data Quality
  - Data-rich handler assessment [high confidence]
  - No fertilizer admixture exposure data
  - No right-of-way sprayer exposure data
  - No crop-specific TCs available
  - DFR studies used to extrapolate REIs for other crops

Atrazine Incident Reports

- Data Sources:
  - OPP Incident Data System
  - Poison Control Centers, 1985-1996
  - California Department of Pesticide Regulation
  - National Pesticide Telecommunication Network

Atrazine Incident Reports

- Poison Control Centers (1993 -1998)
  - 75 occupational illnesses reported
  - 186 adult/ 64 child non-occupational illnesses reported
  - More minor but fewer severe symptoms reported compared to other herbicides

Atrazine Incident Reports

- National Pesticide Telephone Network (1984-91)
  - Ranked 33rd of all pesticides
  - 117 human and 28 animal reports
- National Cancer Institute
  - Follow-up on non-hodgkins lymphoma

Environmental Fate & Effects

James Lin, Environmental Engineer
Mary Frankenberry, Statistician
Douglas Urban, Senior Scientist
Environmental Fate & Effects Division

Environmental Risk Assessment

- Executive Summary
- Environmental Fate Characterization
- Ecological Effects Characterization
- Ecological Risk Characterization

Environmental Fate & Effects Executive Summary

- Atrazine is persistent and mobile in the environment, leading to
  - Widespread detections in surface water and ground water
  - Extensive presence in aquatic environments in areas of high use.

- Potential Adverse effects on sensitive aquatic populations and communities
  - Greatest where concentrations equal or exceed 10 to 20 ug/L recurrently or for prolonged periods.

Environmental Fate & Effects Executive Summary

- Based on Monitoring Data
  - Maximum concentrations at up to 20% of sites exceeded the concentration at which Mortality to Aquatic Plants was found (> 20 ug/L)
  - Maximum concentrations at up to 35% of sites exceeded the concentration at which Effects on Populations & Communities were found (>10 ug/L)
- Frequency and extent of occurrence of adverse effects will vary by
  - Type of water body (e.g., stream, reservoir)
  - Proximity to atrazine applications

Environmental Fate & Effects Executive Summary

- Uncertainties
  - Recovery from the effects of atrazine has been reported
  - Development of resistance to effects has been reported
- Reported Sub-Lethal Effects on Aquatic Organisms & Amphibians
  - Endocrine Effects
  - Olfactory Effects

Environmental Fate Characterization of Atrazine

James Lin
Environmental Engineer
Environmental Fate & Effects Division

Environmental Fate of Atrazine

- Product Chemistry
  - Water solubility: 33 mg/L @ pH 7
  - Vapor pressure: 2.89×10^{-7} mm Hg @ 25 ^{o}C
  - Henry's law constant: 2.48×10^{-9} atm-m^3/mole
  - Octonal/water partition coefficient: log Kow = 2.68 @ 25^{o}C

Environmental Fate of Atrazine

- Stable in hydrolysis, aqueous photolysis
- Half-life ranges from 20 to 146 days in aerobic soil metabolism studies
- Half-life of 159 days in anaerobic soil metabolism study
- Minor degradation in aquatic environment (field study)
- Mobility: Koc of 87.8 ml/g

Degradation of Atrazine in Aquatic Environment

- The half-life for six studies (lakes, mesocosm, and experimental pond) varies from 41 to 237 days with a mean of 159 days.
- Data from the Lake Michigan Lake-Wide Management Plan (EPA data) show that atrazine is quite persistent due to the conditions of cold water, low productivity, high pH (8.2), low nitrate, and low dissolved organic carbon (1.5 mg/L). The estimated half-life in this environment is 31 years, based on degradation in the lake, mass outflows from the lake, and mass loading inputs shut off.

Environmental Fate of Atrazine

- Degradates form in the environment, these were not considered in the ecological risk assessment

- Atmospheric transport
  - Presence in rainfall

Environmental Fate of Atrazine

- Persistence
  - Major degradation mechanism from microbial interactions
  - Aerobic reactions influence more than anaerobic reactions
- Mobility
  - Moderate water solubility and small Koc (Kd) favor movement of atrazine in the dissolved form in runoff and leaching

Aquatic Exposure to Atrazine

- Farm pond environments
  - Modeling approach w/ PRZM and EXAMS
- Stream, river, and reservoir environments
  - Monitoring data (USGS reports and NAWQA results)
- Estuarine environments
  - Monitoring data (Louisiana DEQ, Chesapeake Bay)

Comments on Aquatic Exposure

- Selection of environmental fate data for model inputs in PRZM/EXAMS for farm pond environments
- Analysis of USGS NAWQA monitoring data for streams, rivers and reservoirs
- Sources of monitoring data for estuarine environments

Environmental Fate Data Modeling Inputs

- Ran PRZM/EXAMS using fate data from both EPA and the registrant
- The results are included in the following slide:
  - Scenario #1: original runs (assuming aerial applications with 75% efficiency and 5% drift).
  - Scenario #2: same assumptions with registrant suggested environmental fate data
  - Scenario #3: registrant suggested model inputs with 95% efficiency and 5% drift (EFED's input guidance).
  - Scenario #4: ground application (99% efficiency, 1% drift)

Effects of Modeling Inputs on Farm Pond EECs

		Atrazine EEC Values ppb (µg/L)				
Treated Crop	**Scenario**	**Peak Conc.**	**96-hour AVG**	**21-day AVG**	**60-day AVG**	**90-day AVG**
Sugarcane	**1**	**205**	**204**	**202**	**198**	**194**
(4.0 lb ai/a)	2	167.6	166.7	163.8	157.8	152.9
	3	207	206	203	195	189
	4	200.6	199.6	196.7	189.8	183.8
Corn	**1**	**38.2**	**38**	**37.2**	**35.5**	**34.2**
(2.0 lb ai/a)	2	29.7	29.4	28.4	26.6	25.1
	3	35.3	35	33.8	31.6	30

Analysis of NAWQA Data

- Registrants presented data by combining all of the available sites in the NAWQA program, but did not differentiate among site types
- EPA's analysis examines the data by type of site , such as "agricultural," "urban," or "integrator"
  - large number of agricultural samples

Analysis of NAWQA Data

- **Indicator Sites** - Small watersheds on the order of 20 to 100 square miles generally represented a "predominant" land use (such as agriculture crop).
- **Integrator Sites** – The small watersheds were nested within larger watersheds (on the order of 500 to greater than 1000 square miles) that represented larger rivers and mixed land uses for the purpose of "integrating" the effects of size and mixed uses.
- The number of samples analyzed were **1606**, 650, and 605, respectively, for the **40 agricultural indicator sites**, 11 urban indicator sites, and 14 integrator sites.

NAWQA Monitoring Results

NAWQA DATA Indicator Site (number)	maximum (µg/L)	99th %tile (µg/L)	95th %tile (µg/L)	90th %tile (µg/L)	50th %tile (µg/L)
agriculture (40)	120	13	3.25	1.2	0.027
urban (11)	14	2.75	0.65	0.33	0.041
integrator (14)	27	12.5	5.35	1.95	0.062

Sources of Monitoring Data

Estuarine Environments

- Data Base of the Occurrence and Distribution of Pesticides in Chesapeake Bay

  www.agnic.nal.usda.gov/cbp/pest/atrazine.html

- 1998 Atrazine Report for the Upper Terrebonne Basin

  www.deq.state.la.us/surveillance/atrazine/index.htm

Estuarine Monitoring Results

Chesapeake Bay	max conc (µg/L)	95th %tile	90th %tile	75th %tile	50th %tile
(105 sites)	30	10.3	2.7	1.2	0.4

Louisiana (28 sites)	Peak	95th %tile	90th %tile	75th %tile	50th %tile
Max. Conc. (ug/L)	216.2	210	125.8	34.7	13.3
Mean Conc. (ug/L)	56.7	54.7	24.5	8	4.5

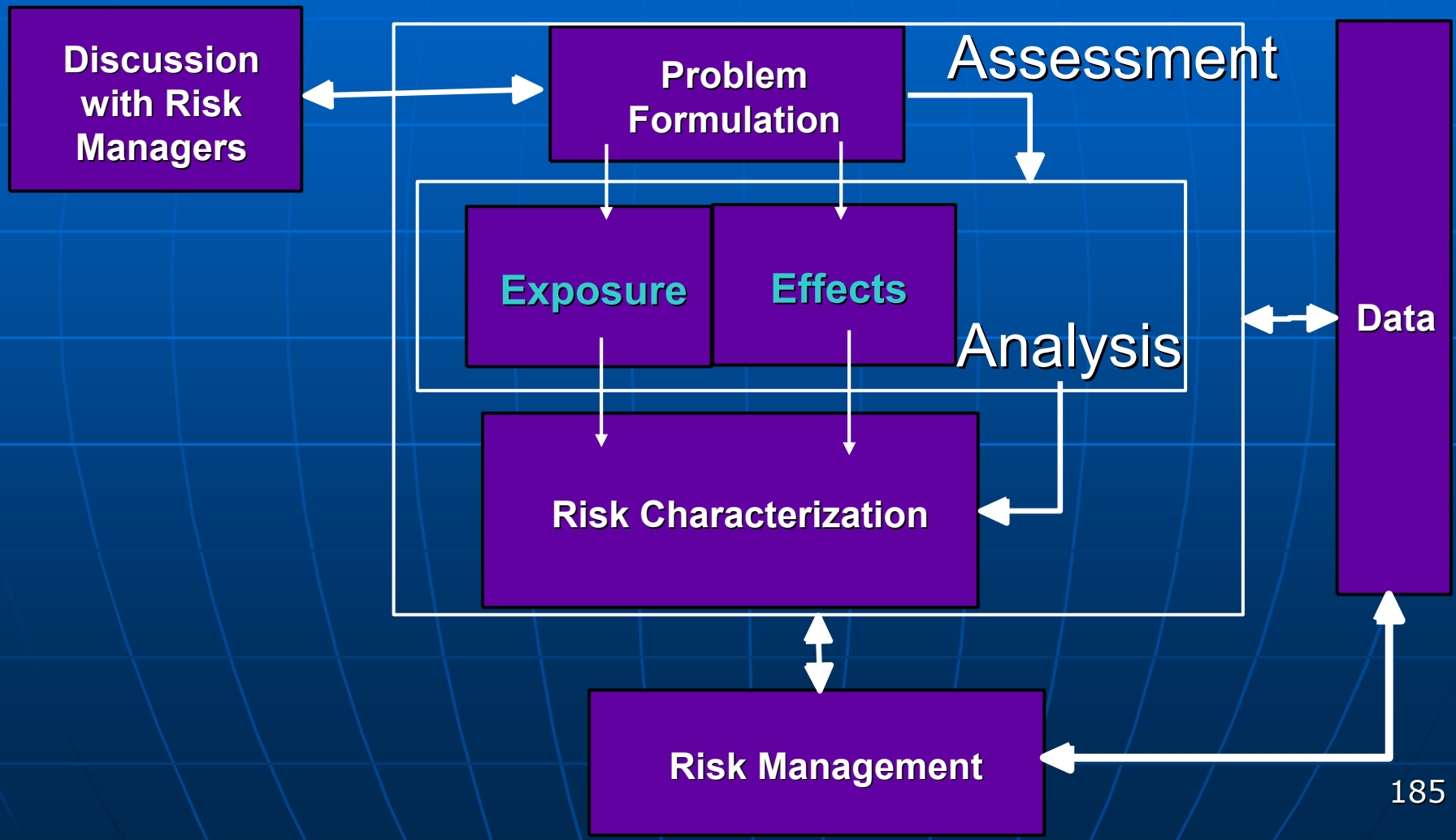
Ecological Effects Characterization of Atrazine

Douglas Urban
Senior Scientist
Environmental Fate & Effects Division

Species	Atrazine Acute Toxicity	Atrazine Chronic Toxicity
Birds	Slightly Toxic [940 mg/kg]	Chronically Toxic [NOAEC = 225 ppm]
Mammals	Slightly Toxic [1,869 mg/kg]	Chronically Toxic [NOAEC = 10 ppm]
Honey Bees	Relatively Non-Toxic [LD50 = 96.7 ug/L]	--
Fish	Moderately Toxic [5,300 ug/L]	Chronically Toxic [NOAEC = 65 ug/L]
Aquatic Invertebrates	Highly Toxic [720 ug/L]	Chronically Toxic [NOAEC = 60 ug/L]
Aquatic & Terrestrial Plants	Very Highly Toxic	--

EPA Ecological Risk Assessment Process

(1998 EPA EcoRisk Guidance)

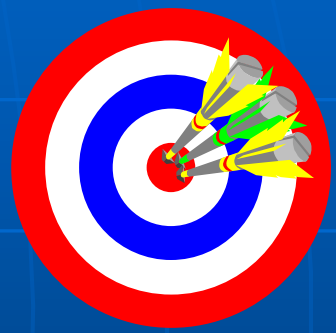


Ecological Risk Characterization

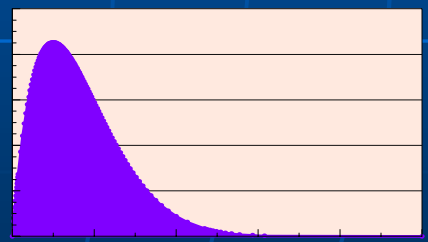
Risk = f (exposure, toxicity)

Difference Between Deterministic & Probabilistic Risk Assessments

- Deterministic – use traditional point estimates of exposure (model) and toxicity (most sensitive species).



- Probabilistic – use distributions of exposure and/or toxicity data.



Ecological Risk Characterization
Overview

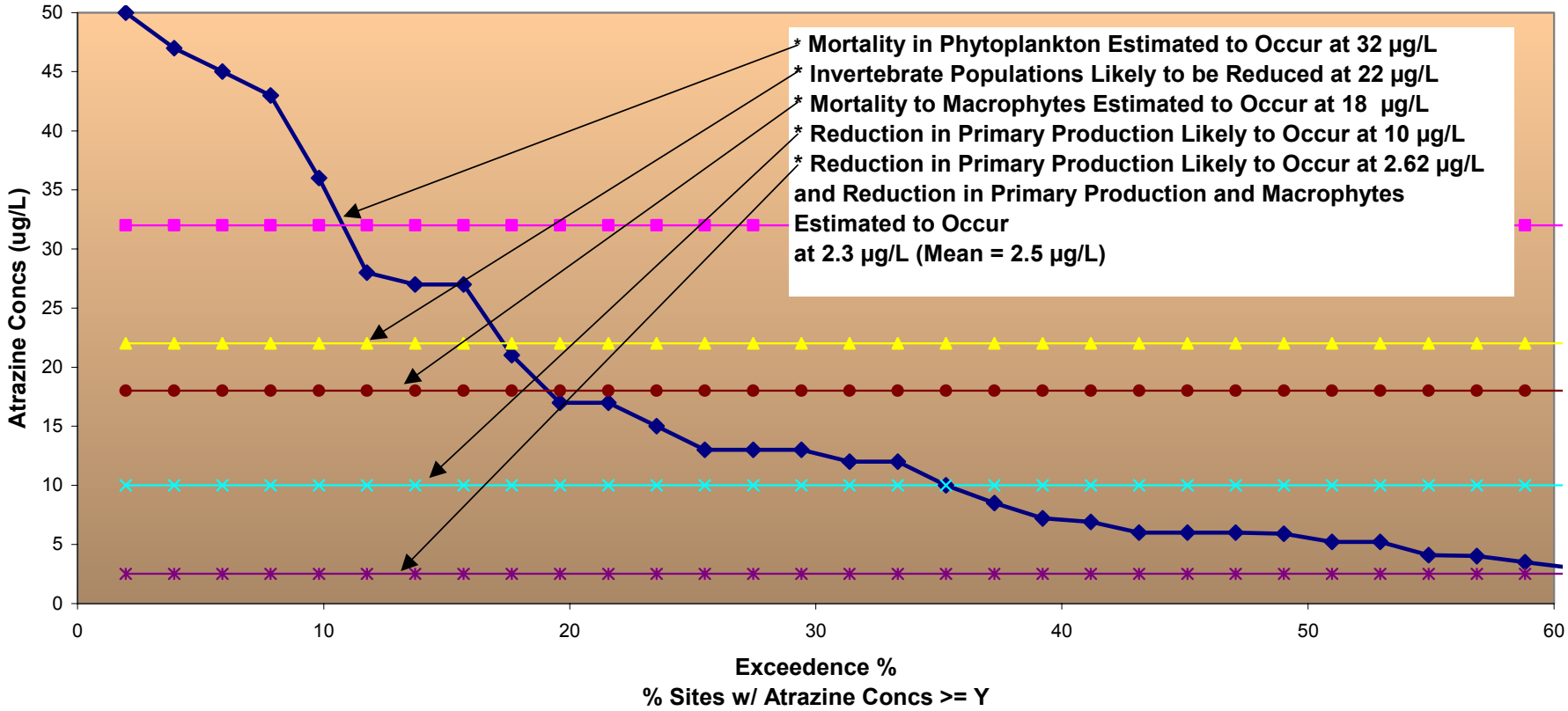
- Screening Level Risk Assessment based on:
  - Point estimates of exposure from modeling data
  - Point estimates of toxicity from laboratory studies

- Refined Risk Assessment based on:
  - Distributions of exposure from monitoring data
  - Point estimates of toxicity from mesocosm and microcosm studies & 10^{th} percentile toxicity values from distributions of toxicity data

Screening Level Risk Assessment vs. Refined Risk Assessment - Examples

Risk Quotient = Exposure Value/Toxicity Value = 4.3 (e.g.)

Figure 8. USGS Mid-Western Stream Sampling Results for 1995 Post-Application Atrazine Concentrations for 50 Streams



Screening Level Ecological Risk Assessment

- Risk Quotients (RQ)
  - Ratio of exposure (estimated environmental concentration; EEC) to toxicity endpoint (non-granular products)
  - RQ is an *index (indicator or measure of a condition)* of the potential for adverse effects in the field.
  - **Acute RQ = EEC/LC_{50} or EC_{50}**
  - **Chronic RQ = EEC/NOAEC**
- Ratio is compared to the Agency's Levels of Concern (LOC)

Screening Level Ecological Risk Assessment

RQs:

- identify pesticide uses not likely to result in an adverse effect
- identify pesticide uses that may result in adverse effects
- do not predict the magnitude of the adverse effect nor the probability (how likely) that adverse effects will occur.

Levels of Concern (LOCs)

- Acute Risk LOC: RQ≥0.5
- Chronic Risk LOC: RQ≥1.0
- Restricted Use LOC:
  - RQ≥0.2 birds & mammals
  - RQ≥0.1 aquatic organisms
- Endangered Species LOC: RQ≥0.1;0.05

Screening Level Risk Assessment: Birds and Mammals

Species		Level of Concern	RQs
Acute	Birds	RQ ≥ 0.5	<0.5
	Mammals		<0.5
Chronic	Birds	RQ ≥ 1.0	<1 to 4.3
	Mammals		1.6 to 96

Screening Level Risk Assessment: Fish and Aquatic Invertebrates

Duration	Level of Concern	RQs
Fish (freshwater)		
Acute	RQ $\geq$ 0.5	< 0.5
Chronic	RQ $\geq$ 1.0	<1 to 3.1
Aquatic Invertebrates (freshwater)		
Acute	RQ $\geq$ 0.5	< 0.5
Chronic	RQ $\geq$ 1.0	<1 to 3.4

Screening Level Risk Assessment: Non-Target Terrestrial and Aquatic Plants

Species	Level of Concern	RQs
Terrestrial		
9 Species	RQ $\geq$ 1.0	< 1 to 280
Aquatic		
Algae	RQ $\geq$ 1.0	< 1 to 4.2
Vascular	RQ $\geq$ 1.0	<1 to 5.5

Summary of Screening Level Risk Assessment

- LOC exceedances for:
- Chronic effects on mammals
- Acute effects on non-target terrestrial plants
- Acute effects on aquatic vascular plants and algae

Refinements to the Aquatic Risk Assessment

- Used simulated & actual aquatic field studies (indirect effects)
- Used 10th percentile toxicity values from distributions of toxicity data
- Used extensive monitoring data – freshwater streams, lakes, reservoirs, estuarine areas.

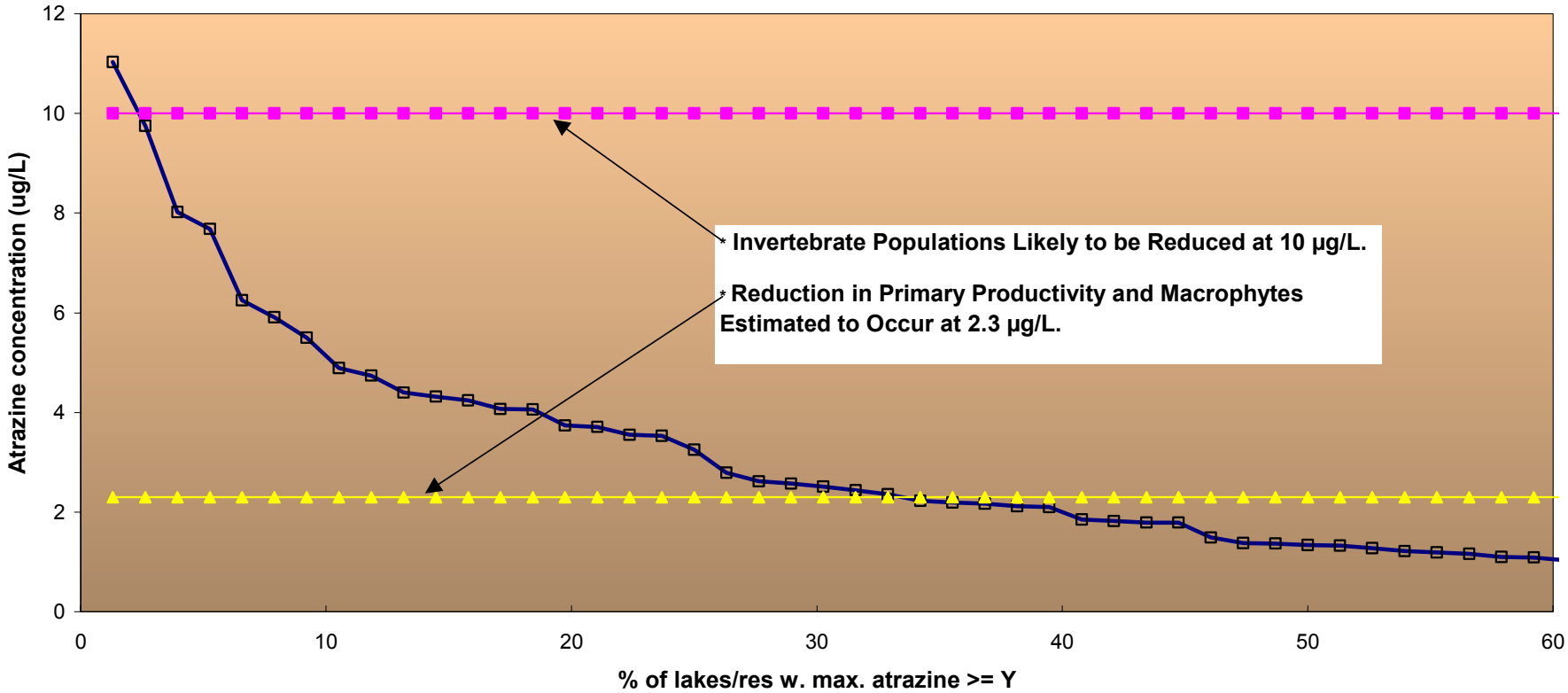
Refined Aquatic Risk Assessment

- Exposure - Cumulative Exceedence Curves of maximum atrazine concentrations from monitoring data plotted verses the % of sites with equal or greater concentrations

- Toxicity - Horizontal Lines for toxicity endpoint values representing adverse effects from field studies and 10^{th} percentile toxicity values from distributions of toxicity data.

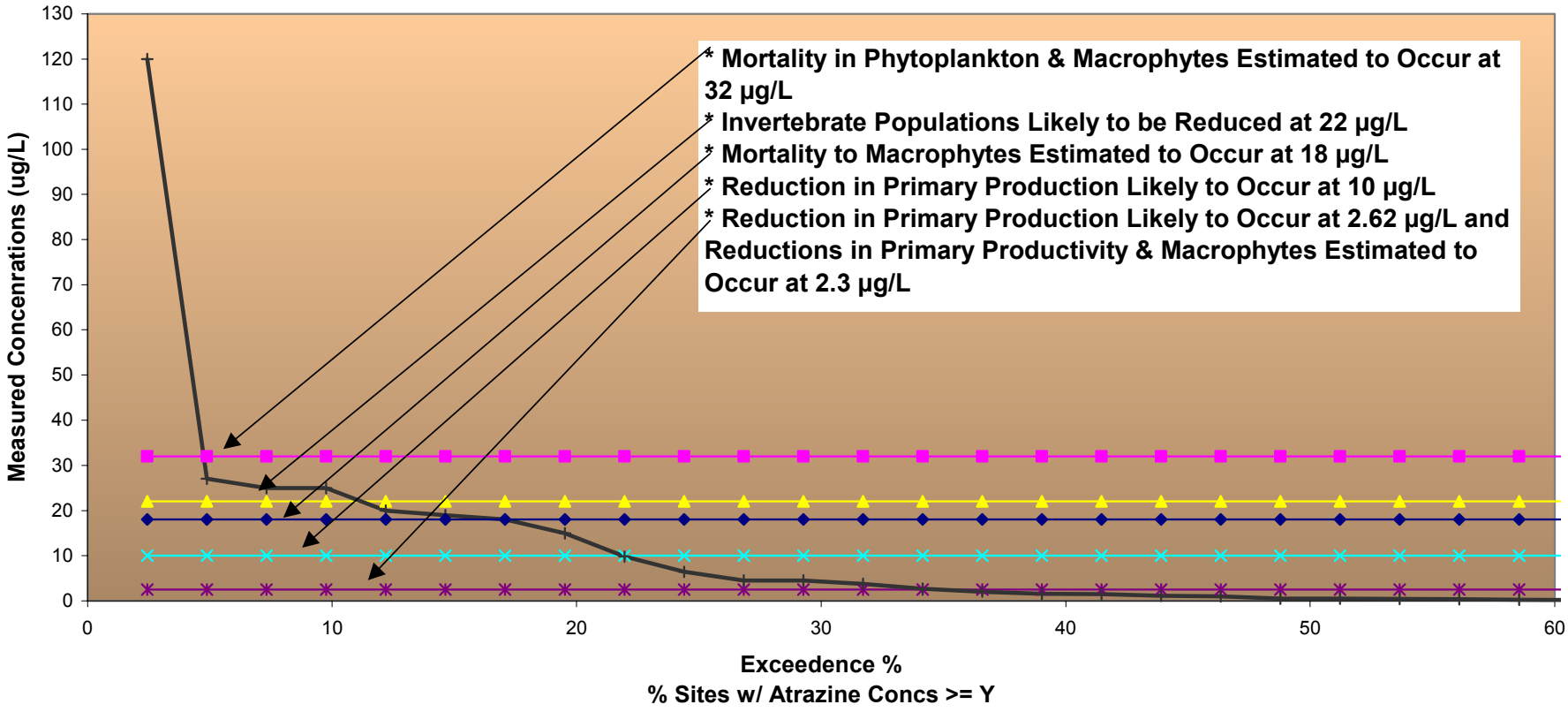
Refined Aquatic Risk Assessment - Lakes

Figure 5. USGS 1993 Mid-Western Lake/Reservoir Sampling Results
Maximum Atrazine Concentrations



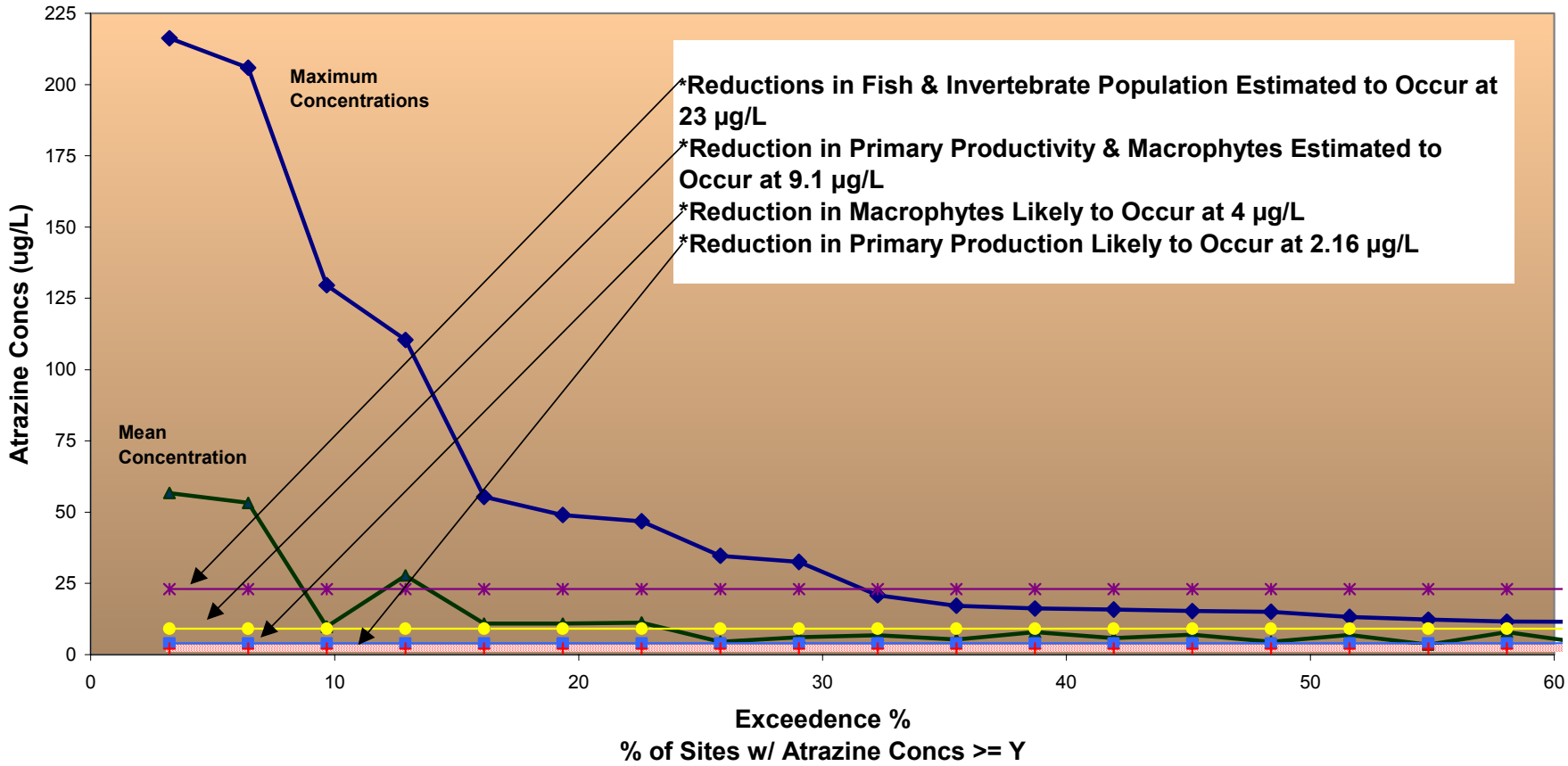
Refined Aquatic Risk Assessment - Streams

Figure 11. National Water Quality Assessment Program (NAWQA): Maximum Atrazine Concentrations for 40 Agricultural Sites



Refined Aquatic Risk Assessment - Estuarine Areas

Figure 12. Louisiana Max & Mean Atrazine Concentrations By Site (28 Sites) in 1998



Review of Syngenta's Probabilistic Risk Assessment

- *"Aquatic Ecological Risk Assessment of Atrazine – A Tiered Probabilistic Approach, A Report of an Expert Panel"* -- Submitted to EPA January, 2001.
- Reviewed by EPA with technical assistance of an expert contractor (Syracuse Research Corporation).
- Met with Syngenta & Expert Panel – December , 2001 and March, 2002.
- Continuing to review additional submissions & engage in ongoing dialogue.

Syngenta's Probabilistic Assessment

After a thorough, scientific evaluation, OPP did not rely on Syngenta's conclusions because:

- A full probabilistic assessment cannot be conducted for community & population level effects (indirect effects);
- The assessment lacked peer reviewed exposure models (documentation, assumptions, and sensitivity analyses); and
- The "Total Risk" summary statistic is an index; problems with interpretation and use in regulatory decision making.

Reported Sub-Lethal Effects

- **Endocrine effects**
  - Bass [Syngenta (Wieser & Gross, 2002)] Steroidogenic effects at ~50 ug/L
  - Frogs (Hayes, 2002) Steroidogenic effects at ~0.1 ug/L
- **Olfactory Effects**
  - Salmon (Moore & Waring, 1998) Effects at ~0.5 ug/L

No Endocrine Effects
[Recent Syngenta Submissions]

- Turtle Eggs
- Alligator Eggs
- *Daphnia pulicaria*
- Frogs (recent presentation; no data to evaluate)

Refined Assessment Aquatic Risk Concerns

- Reductions in primary productivity
- Reductions in populations of aquatic macrophytes, invertebrates & fish
- Indirect effects on aquatic communities – loss of sensitive species resulting in changes in community structure & function.

Summary of the Refined Aquatic Assessment

- In areas of high atrazine use:
  - Widespread exposure to aquatic environments
  - Potential adverse effects on sensitive populations and communities
  - Potential effects likely to be greatest where concentrations recurrently or consistently exceed 10 to 20 ug/L.

Summary, Cont.

- Frequency of occurrence of adverse effects
  - Maximum concentrations at up to 20% of sites exceeded the concentration at which Mortality to Aquatic Plants were found (> 20 ug/L)
  - Maximum concentrations at up to 35% of sites exceeded the concentration at which Effects on Populations & Communities were found (>10 ug/L)

- Frequency and extent of occurrence of adverse effects will vary by
  - Type of water body (e.g., stream, reservoir)
  - Proximity to atrazine applications

Summary, Cont.

- Uncertainties
  - Recovery from the effects of atrazine has been reported
  - Development of resistance to effects has been reported
- Reported Sub-Lethal Effects on Aquatic Organisms & Amphibians
  - Endocrine Effects
  - Olfactory Effects

Atrazine – Safe Drinking Water Act

Rita Schoeny
Associate Director,
Health and Ecological Criteria Division
Office of Science and Technology,
Office of Water

Safe Drinking Water Act: Atrazine standard

- Current Drinking Water Standard for atrazine in public water systems:
  - rule published in 1991
  - MCL = 3 ppb
  - based on MCLG = 3 ppb
  - parent compound only, no degradates
  - compliance based on running annual average -- quarterly samples or single annual sample
  - exceedence is a violation that triggers reporting requirements and public notification

Safe Drinking Water Act: Atrazine standard

- What is an MCLG?
  - Maximum Contaminant Level Goal
  - Considers only human health risk
  - Non-enforceable public health goal

Safe Drinking Water Act: MCLG Derivation

- Carcinogens
  - MCLG
    - Has been 0 for Groups I and II (known and probable human carcinogen categories)
      - (1986 Group A and Group B)
    - Group III (possible human carcinogen category)
      - based on RfD additional 10 fold safety factor
      - (1986 Group C)

Safe Drinking Water Act: MCLG Derivation

- Non-Carcinogens, Non-linear Dose Response
  - MCLG = DWEL X RSC
    - DWEL = RfD x 70 kg per person / 2 L per day
    - RSC = Relative Source Contribution; contribution to total exposure from water (default was 20%; now Human Health Methodology for Ambient Water Quality Criteria is used)

Safe Drinking Water Act: Atrazine Standard

- What is an MCL?
  - Maximum Contaminant Level
  - Highest concentration of contaminant allowed in Public Water System water
  - Set as close to MCLG as feasible
    - Considers treatment options
    - Considers analytic level of detection
  - Takes cost into consideration
  - Cost / benefit analysis required under SDWA

Safe Drinking Water Act: Atrazine Standard

- Atrazine regulated as a result of 1986 SDWA amendments
  - atrazine was one of 83 contaminants listed in the statute as requiring regulation
  - on list of 83 because it was found in source water by the National Pesticide Survey (1984)
- The current MCLG of 3 ppb based on:
  - a two generation study of rats measuring reduced pup weights; NOAEL = 0.5 mg/kg/day
  - 100-fold UF resulted in an RfD of 0.005 mg/kg/day
  - an additional 10-fold SF was applied to account for the Cancer Classification in Group C: Possible Human Carcinogen

Safe Drinking Water Act: Since 1991

- Following promulgation, EPA revised RfD in 1992 from 0.005 mg/kg/day to 0.035 mg/kg/day based on life time rat study;manufacturer petitioned EPA to revise MCL
- EPA denied petition, and litigant sought judicial review
- By 1994, OPP was working on Special Review of atrazine; new data was submitted by manufacturer

Safe Drinking Water Act: Since 1991

- In February 1999, EPA announced that it will re-evaluate MCL for atrazine after revised risk assessment is completed
  - in response to Children's Health Advisory Committee
- In July 1999, Environmental Working Group issued a report
  - highlighted concern that seasonally increased atrazine exposure could impact sensitive populations

Safe Drinking Water Act: Next Steps

- Based on the revised Human Health Risk Assessment, the Office of Water will
  - begin process to update **Health Advisory Document**
  - re-evaluate atrazine MCL as part of **6 Year Review** of regulated contaminants under SDWA
    - EPA will take public comment on the Notice of Intent from mid-April to mid-June

1998 Contaminant Candidate List (CCL) Triazines & Degradates

- Includes, but not limited to cyanazine and atrazine-desethyl
  - Consider regulation as a class of compounds
- Research Needs:
  - Occurrence
    - Limited data on occurrence of total triazines and degradates in drinking water
  - Analytical Methods
    - Monitoring methods research needed

Atrazine – Clean Water Act

Frank Gostomski
Office of Science and Technology,
Office of Water

Atrazine – Clean Water Act

- National Ambient Water Quality Criterion Document
  - Acute and chronic criteria recommendations proposed for protection of aquatic life
  - Draft freshwater and saltwater criteria available for atrazine
  - Criteria may form basis for State and Tribal water quality standards

Atrazine – Clean Water Act

- Freshwater Acute Criterion 350 ppb
- Freshwater Chronic Criterion 12 ppb

- Saltwater Acute Criterion 760 ppb
- Saltwater Chronic Criterion 26 ppb

Atrazine – Clean Water Act

- Notice of availability of draft atrazine water quality criteria document published in *Federal Register* on September 26, 2001

  (66 FR 49186)
- Public comment taken until January 25, 2002
- Final document expected in Fall 2002

Summary, Conclusions, & Risk Management

Kimberly Nesci Lowe
Chemical Review Manager, Atrazine
Special Review and Reregistration Division

Atrazine – Summary of Risks

- Human Heath Risks
  - Dietary (drinking water)
    - Risks of concern have been identified for CWS and rural wells
  - Residential
    - Risks of concern have been identified for residential applicators applying via bellygrinder
    - Postapplication risks of concern have been identified for liquid applications to turf
  - Aggregate
    - Chronic and intermediate-term risks of concern
      - Same as drinking water risk estimates
    - Short-term aggregate risks of concern
      - Same as residential risk estimates

Atrazine – Summary of Risks

- Human Heath Risks
  - Occupational
    - Risks of concern identified for handlers of large quantities of atrazine (i.e., to treat large acreages)
    - Risks of concern identified for postapplication scouting of sugarcane

Atrazine – Summary of Risks

- Ecological Concerns
  - Potential effects identified for aquatic communities and ecosystems based on:
    - Widespread presence in surface water
    - Potential indirect effects on aquatic invertebrate and fish populations
  - Potential sublethal effects, including endocrine effects and olfactory effects

Atrazine – Risk Management Process

- Atrazine's risk management discussions will involve many parties
  - EPA's Regions
  - EPA's Office of Water
  - United States Department of Agriculture
  - State regulatory agencies
  - Stakeholders (registrants, growers and grower groups, public interest organizations, water associations, other interested parties)

Atrazine – Risk Management Process

- Targeted to areas of concern
- Consider best management practices (BMPs) currently in place
- Consider benefits under FIFRA

Atrazine – Risk Management

- Consider mitigation implemented at the state level
- Include label harmonization
  - Only uses and rates supported by data
  - Current labels should include all prior risk management measures
  - Label harmonization itself may help to reduce some exposures to atrazine

Atrazine – Risk Management Possibilities

- Modify use patterns
  - Reduce use rates
  - Eliminate or restrict uses
  - Eliminate specific formulations
- Require:
  - Vegetative buffers
  - Setbacks
- Restrict application methods
- Regional restrictions
- Protective equipment
- Require additional data to further characterize the risk
  - Monitoring
  - Endocrine & olfactory effects

Atrazine – Additional Information That Could Impact Risk Assessment and Risk Management Decisions

- Water trend analysis data provided by the registrant
- Additional water monitoring data
- Phase 5 comments on the revised risk assessment and risk management
- Benefits

Atrazine – Next Steps

- Phase 5
  - 60-day public comment period
  - Public submits comments on risk assessment and risk management strategies
  - Opportunities for stakeholders to meet with EPA
- Phase 6
  - Develop risk management strategies
  - Stakeholder discussions
  - Finalize risk management decisions
  - Issue the IRED by August 2002

Triazines – Next Steps

- Simazine risk assessments and IRED (2004)
- Propazine risk assessments
- Cumulative triazines assessment

Closing Remarks & Questions

Lois Rossi
Director, Special Review and Reregistration Division